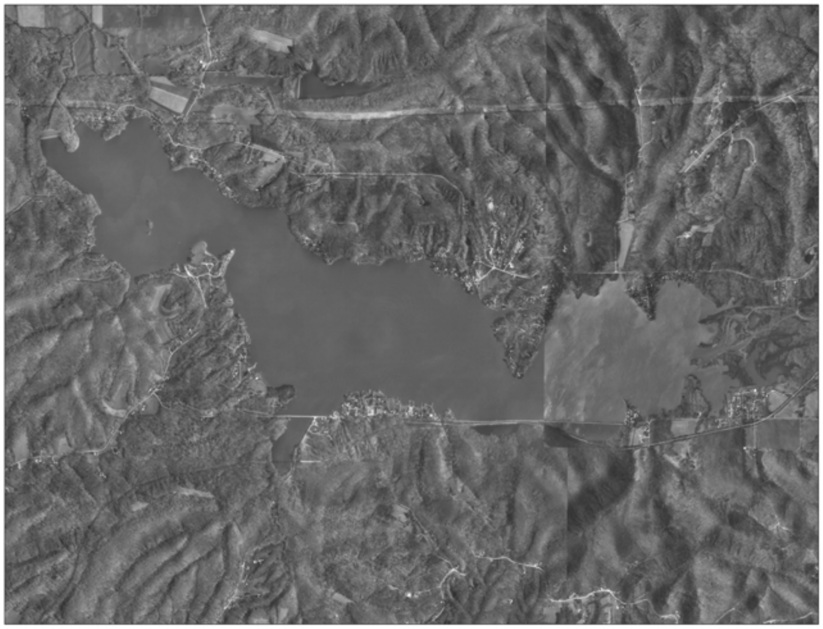


Lake Lemon
Aquatic Vegetation Management Plan

February 25, 2005

Prepared for:
Lake Lemon Conservancy District
7599 North Tunnel Road
Unionville, IN 47486

Prepared by:
Nathan W. Long
Aquatic Control, Inc.
PO Box 100
Seymour, Indiana 47274

Executive Summary

Aquatic Control was contracted by the Lake Lemon Conservancy District to complete aquatic vegetation sampling in order to update their lakewide, long-term integrated aquatic vegetation management plan. Funding for development of this plan was obtained from the Lake Lemon Conservancy District (LLCD) and the Indiana Department of Natural Resources-Division of Soil Conservation as part of the Lake and River Enhancement fund (LARE). This plan was updated as a prerequisite to eligibility for LARE program funding to control exotic or nuisance species.

Aquatic vegetation is an important component of lakes in Indiana; however, as a result of many factors this vegetation can develop to a nuisance level. Nuisance aquatic vegetation, as used in this paper, describes plant growth that negatively impacts the present uses of the lake including fishing, boating, swimming, aesthetic, and lakefront property values. The primary nuisance species within Lake Lemon is the exotic plant Eurasian watermilfoil (*Myriophyllum spicatum*). The negative impact of this species on native aquatic vegetation, fish populations, water quality, and other factors is well documented and will be discussed in further detail. American Lotus (*Nelumbo lutea*), spatterdock (*Nuphar spp.*), and small pondweed (*Potamogeton pusillus*) are also abundant in Lake Lemon and can create nuisance situations around dock areas and boating lanes. The primary recommendations for plant control within Lake Lemon includes the use of triclopyr herbicide to selectively control Eurasian watermilfoil throughout the lake. This type of treatment should expedite the re-establishment of native vegetation and relieve nuisance conditions caused by Eurasian watermilfoil. A more intensive plant sampling effort should also be initiated in order to document the effects of the treatment program on native and exotic vegetation.

Acknowledgements

Funding for the vegetation sampling and preparation of an aquatic vegetation management plan was provided by the Indiana Department of Natural Resources – Division of Soil Conservation and the Lake Lemon Conservancy District. Aquatic Control Inc completed the field work, data processing, and map generation. Identification and verification of some plant specimens was provided by Dr. Robin Scribailo of Purdue University North Central. Special thanks are due to Bob Madden and Coleman Smith of the Lake Lemon Conservancy District for their help in initiating and completing this project. Special thanks are given to Jed Pearson, District Fisheries Biologist for the Indiana Department of Natural Resources-Division of Fish And Wildlife, for his assistance with the plant sampling database. Special thanks are given to IDNR biologists Dave Kittaka and Cecil Rich for their review of this report. Author of this report is Nathan Long of Aquatic Control. The author would like to acknowledge the valuable input from David Isaacs, Brian Isaacs, Joey Leach, and Barbie Huber of Aquatic Control for their field assistance, map generation, review, and editing of this report.

Table of Contents

List of Figures

List of Tables

List of Appendices

Introduction

Aquatic Control was contracted by the Lake Lemon Conservancy District to complete aquatic vegetation sampling in order to update a lakewide, long-term integrated aquatic vegetation management plan. Funding for the update of this plan was obtained from the Indiana Department of Natural Resources-Division of Soil Conservation as part of the Lake and River Enhancement fund (LARE). This plan was also updated as a prerequisite to eligibility for LARE program funding to control exotic or nuisance species.

The Lake Lemon Conservancy District (LLCD) was formed in 1995 and is made up of a group of residents/freeholders. The LLCD was formulated to operate, maintain, and manage Lake Lemon for recreation, wildlife habitat, and water quality. The LLCD has a management history which includes several shoreline erosion control projects, dam maintenance, and a main-channel restoration project. The LLCD also participates in the Volunteer Clean Lakes Program, conducts water quality testing, and created a watershed management plant. The LLCD's aggressive best management practice philosophy has lead to the recognition and proactive treatment of nuisance aquatic macrophytes. One of LLCD's goals is to manage the plants with a comprehensive, controlled, and measurable management plan.

The aquatic plant management goals of the Lake Lemon Conservancy District are as follows:

1. Prevent further water use impairment by aquatic plants.
2. Restore and maintain dock access for residents restricted by nuisance vegetation.
3. Increase fishable and swimable shoreline.
4. Maintain aquatic plant populations at levels and/or in areas that are beneficial to water quality protection and to fish and wildlife populations.
5. Maintain aquatic plant diversity through the intensive control of exotics.
6. Promote the use of environmentally sound aquatic plant management practices.
7. Promote the development of comprehensive aquatic plant management methods.
8. Provide educational and management tools for the District for future years (Hoffman, 2000).

Eurasian watermilfoil is the primary nuisance exotic species in Lake Lemon. This species restricts boating, swimming, and fishing activities. The exotic species curlyleaf pondweed and purple loosestrife are also present in much less abundance in and around Lake Lemon. The LLCD contracted Aquatic Control Inc. to update their Aquatic Vegetation Management Plan in order to more accurately document the plant community within Lake Lemon and obtain funding to more aggressively pursue Eurasian watermilfoil.

Watershed and Water Body Characteristics

Lake Lemon is a 1512-acre reservoir located in Unionville, Indiana. It is the 11th largest lake in Indiana and was constructed in 1953 for flood control, recreation, and as a drinking water source for the City of Bloomington. The lake was utilized for drinking water until the mid-1970's and today serves as a backup water supply source for the City of Bloomington Water Utility. Historically, Lake Lemon has provided many residents of south central Indiana with a great boating, fishing, and swimming resource. Recently, Lake Lemon has drawn interest as a training laboratory for Indiana University Limnology students and as a sanctuary for avid bird-watchers in the community (Hoffman, 2000). The main inflow into Lake Lemon is Bean Blossom Creek, which drains the major part of the lakes 70.2 square-mile watershed (Hartke & Hill, 1970). The majority of the watershed is forested, but contains highly erodable soils. This has led to high sediment deposits in the east end of the lake.

The Lake Lemon Conservancy District (LLCD) has been active in its efforts to reduce sedimentation and improve water quality. LLCD has sponsored shoreline stabilization projects constructed in 1998, 2000, 2001,and 2002. More than 2,892 linear feet of critical shoreline susceptible to erosion has been stabilized. The Lake and River Enhancement Program (LARE) provided more than $300,000 cost-share funding for this project. In addition to the shoreline stabilization projects, a watershed management plan was completed in 2001. The watershed management project specified four items for immediate action:

1. Convene a Watershed Steering Committee.
2. Obtain necessary permits for the Lake Lemon east end sedimentation/restoration.
3. Submit an application to IDEM for Clean Water Act Section 319 grant for a streambank stablilzation and demonstration project.
4. Submit an application to the Federal Emergency Management Agency for a Hazard Mitigation Grant Program for a flood impact and mitigation study (Malcom Pirnie, Inc., 2002).

To better understand the bathymetry and sediment characteristics of the lake, Remetrix Inc. was contracted in 2001 to complete a study focused on sedimentation in Lake Lemon (Figure 1 & 2). This study resulted in some valuable information, including a detailed bathymetric map, up to date volume calculations, and sediment depth data. The results of the study determined the area of Lake Lemon to be 1,512 acres and the average depth to be 9.5 feet (Remetrix Inc, 2003). This information will be used to make more accurate management recommendations.

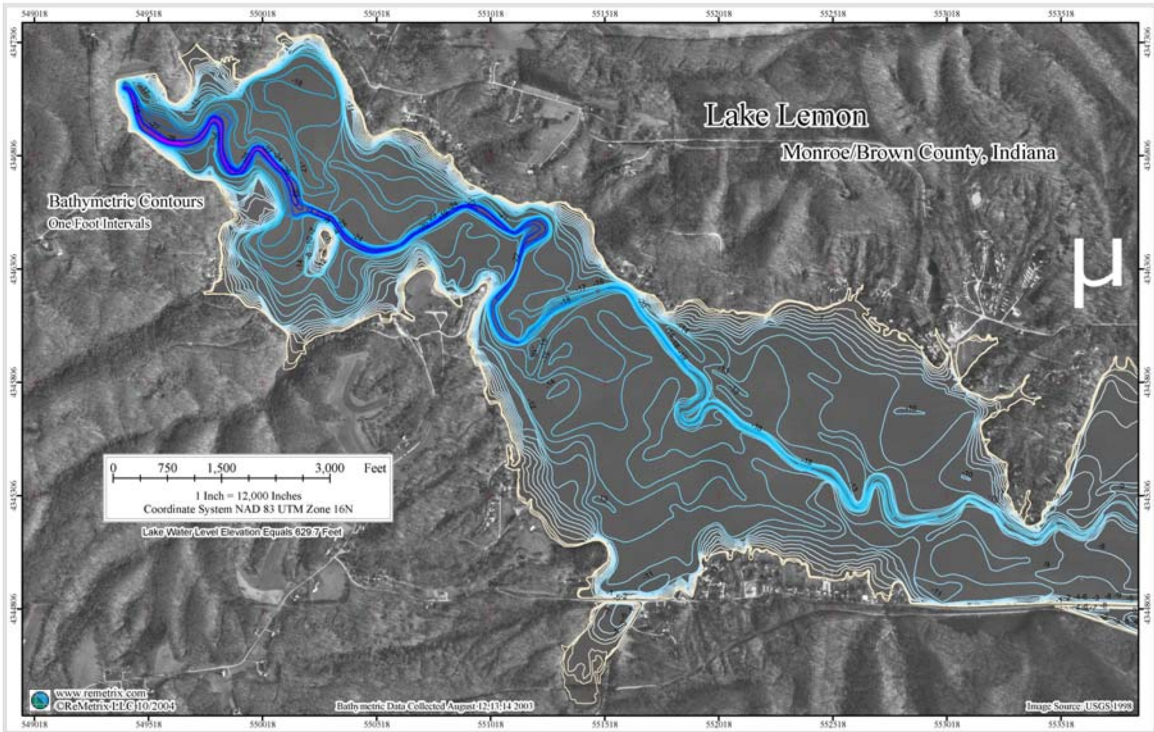


Figure 1. Bathymetric Map of West Section of Lake Lemon (Remetrix, 2004)

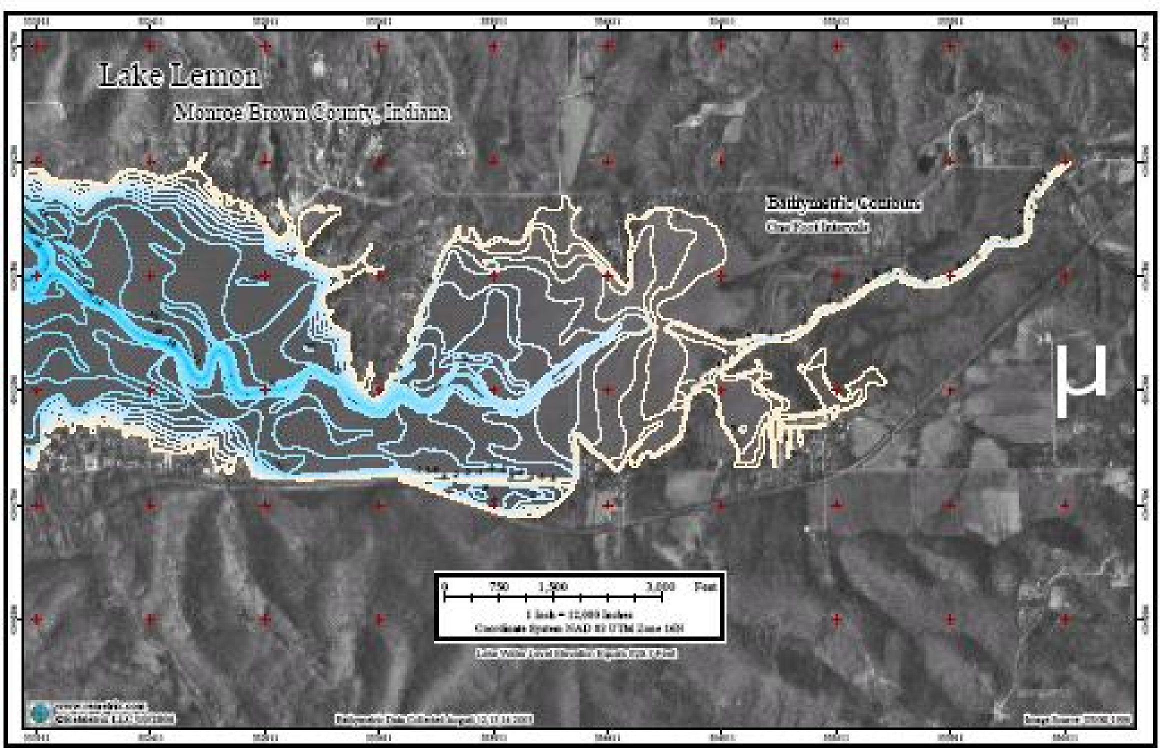


Figure 2. Bathymetric Map of East Section of Lake Lemon (Remetrix, 2004)

Indiana University's School of Public and Environmental Affairs (SPEA) has conducted water quality sampling on Lake Lemon since 1996. Samples are collected three times a year from four different locations within the lake. The following parameters are measured; pH, alkalinity, conductivity, dissolved oxygen, temperature, total phosphorus, soluble reactive phosphorus, nitrate, ammonia, total organic nitrogen, total suspended solids, and fecal coliform bacteria. All parameters tested indicate Lake Lemon is a hypoeurtrophic reservoir. No significant changes have occurred in any of the above parameters since testing began.

It is clear that Lake Lemon has a watershed that is conducive to siltation and phosphorus loading. This can lead to nuisance algae blooms, increased shallow areas, and an overall degradation of water quality. Many projects have been initiated with the focus on reducing sedimentation and improving Lake Lemon's water quality. These are initial steps in a long-term plan to slow the eutrophication process. However, improvement of the watershed and reduction in phosphorus loading will not control nuisance macrophytes. Typically, as watersheds are improved, water clarity will increase. This in turn will increase light penetration and allow for vegetation to grow in deeper water. Submersed vegetation obtains the majority of necessary nutrients from the sediment and most Indiana sediments contain sufficient nutrients for plant growth. The Department of Fisheries and Aquatic Sciences at the University of Florida recently conducted a study comparing the amount of available nutrients to plant growth. They sampled aquatic plant in 319 lakes between 1983 and 1999 and found no significant correlation between nutrients in lake water and the abundance of rooted aquatic plants (Bachman et. al., 2002).

Fisheries

Fish surveys were completed in 1982 by IDNR and in 2000 by Aquatic Control Inc. The 2000 survey collected a total of 4,488 fish weighing 1,152 pounds and representing 27 different species. Yellow bass (*Morone mississippiensis*) was the most abundant species collected (28% of total sample by number), followed by bluegill (*Lepomis macrochirus*) (25%), gizzard shad (*Dorosoma cepedianum*) (14%), white crappie (*Pomoxis annularis*) (8%), largemouth bass (*Micropterus salmoides*) (6%), brook silverside (*Labidesthes sicculus*) (5%), and longear sunfish (*Lepomis megalotis*) (4%). A wide diversity of species comprised the remaining ten percent of the sample (Table 1).

Table 1. Overall species composition, relative abundance, weight, and percent weight of fishes from Lake Lemon, September 26- 29, 2000 (Aquatic Control, 2001).

Common Name	Scientific Name	Number	Relative Abundance	Weight	Percent Weight
Yellow bass	*Morone mississippienis*	1257	28.01%	105.76	9.18%
Bluegill	*Lepomis macrochirus*	1131	25.20%	99.74	8.66%
Gizzard shad	*Dorosoma cepedianum*	623	13.88%	65.45	5.68%
White crappie	*Pomoxis annularis*	345	7.69%	37.72	3.28%
Largemouth bass	*Micropterus salmoides*	261	5.82%	266.40	23.13%
Brook silverside	*Labidesthes sicculus*	245	5.46%	2.45	0.21%
Longear sunfish	*Lepomis megalotis*	178	3.97%	13.58	1.18%
Golden redhorse	*Moxostoma erythrurum*	77	1.72%	122.88	10.67%
Spotted bass	*Micropterus punctulatus*	74	1.65%	41.34	3.59%
Spotted sucker	*Minytrema melanops*	52	1.16%	70.90	6.16%
Yellow perch	*Perca flavescens*	51	1.14%	5.07	0.44%
Black redhorse	*Moxostoma duquesnei*	37	0.82%	38.01	3.30%
Common carp	*Cyprinus carpio*	28	0.62%	196.67	17.08%
Redear sunfish	*Lepomis microlophus*	27	0.60%	9.55	0.83%
Golden shiner	*Notemigonus crysoleucas*	19	0.42%	1.86	0.16%
Flathead catfish	*Pylodictis olivaris*	15	0.33%	14.99	1.30%
Spotfin Shiner	*Cyprinella spiloptera*	12	0.27%	0.12	0.01%
Channnel catfish	*Ictalurus punctatus*	10	0.22%	17.14	1.49%
Warmouth	*Lepomis gulosis*	9	0.20%	0.86	0.07%
Bowfin	*Amia calva*	8	0.18%	37.00	3.21%
Green sunfish	*Lepomis cyanellus*	7	0.16%	1.20	0.10%
Black crappie	*Pomoxis nigromaculatus*	7	0.16%	1.26	0.11%
Northern hog sucker	*Hypentelium nigricans*	5	0.11%	1.14	0.10%
Logperch	*Percina caprodes*	3	0.07%	0.21	0.02%
Bluntnose minnow	*Pimephales notatus*	1	0.02%	0.01	0.00%
Pumpkinseed	*Lepomis gibbosus*	1	0.02%	0.25	0.02%
Chestnut lamprey	*Ichthyomyzon castaneus*	1	0.02%	0.15	0.01%
	TOTAL	4488		1152	

According to the survey report, Lake Lemon should provide excellent largemouth bass fishing especially for large individuals, but bluegill and crappie were not reaching quality sizes. The primary recommendations include the removal of harvest restrictions on bluegill, yellow bass, and crappie; continuance of water quality improvement projects; limits on largemouth bass tournaments; maintaining largemouth bass length restrictions; increased control of Eurasian watermilfoil and regular updates to the aquatic vegetation management plan; initiation of a creel survey; a brief fish survey in 2001 or 2002; and an increase in the amount of artificial structure (Aquatic Control Inc., 2000). With the exception of the brief fish survey, most of the fisheries management recommendations have been initiated by the Conservancy District.

In most cases, aquatic vegetation is beneficial to the majority of fish species. Submersed vegetation provides cover for small and large fish, can provide habitat for invertebrates, and can have positive influences on the overall water quality. However, extensive dense beds of vegetation can have negative impacts on the fishery. Dr. Mike Maceina of Auburn University found that dense stands of Eurasian watermilfoil on Lake Guntersville proved to be detrimental to bass reproduction due to the survival of too many small bass. This led to below normal growth rates for largemouth bass and lower survival to age 1. Maceina found higher age 1 bass density in areas that contained no plants verses dense Eurasian watermilfoil stands (Maceina, 2001). Bluegill growth rates can also be affected by dense stands of Eurasian watermilfoil. It is well known by fisheries biologists that overabundant dense plant cover gives bluegill an increased ability to avoid predation and increases the survival of small young fish, which can lead to stunted growth.

Present Water Body Uses

Approximately 530 homes line the shore and channels of Lake Lemon. A large number of these homes have docks and/or swimming areas in front of their residences. A majority of the residents own fishing or pleasure boats. Historically, Lake Lemon has provided many residents of south central Indiana with great boating, fishing, and swimming resources. At a recent meeting held to discuss the updated management plan, fishing, swimming, and boating were chosen as the primary uses of Lake Lemon.

The LLCD operates a boat ramp at Riddle Point Park and there are also several private boat ramps located at marinas around the lake. Several bass tournaments launch from Riddle Point Park each year. A popular beach is also located within this park. The Indiana University sailing club has a clubhouse and marina on the south side of the lake. In the upper end of Lake Lemon a wild bird viewing area is present which overlooks the large wetland area (Figure 3).

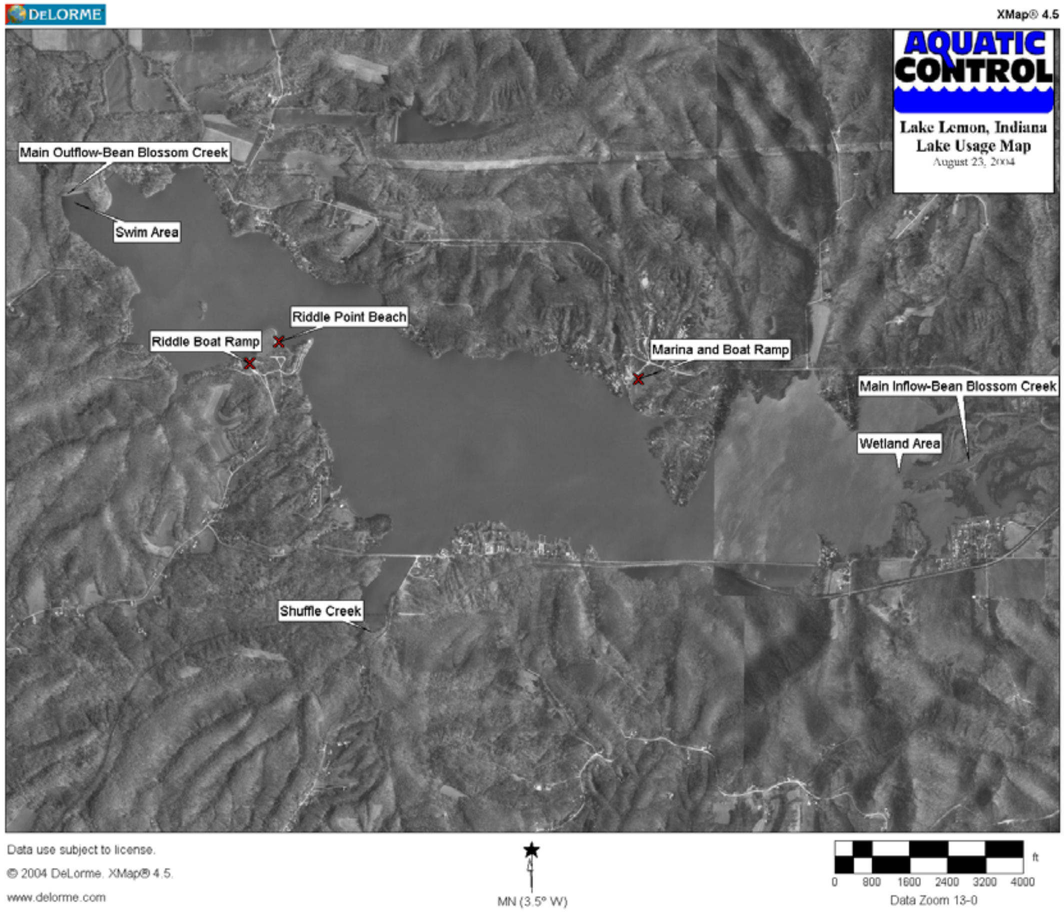


Figure 3. Lake Usage Map (not to scale see appendix)

Aquatic Plant Community

Various types of aquatic plant sampling has been completed on Lake Lemon since the 1970's. Eurasian watermilfoil was first documented in Lake Lemon in the late 1970's and spread to cover approximately 75% of the lake at its peak abundance (Hoffman, 2000). According to a Diagnostic/Feasibility Study conducted in 1986 by the Indiana University School of Public and Environmental Affairs, one of the "major water quality problems in Lake Lemon is the dense growth of Eurasian watermilfoil which was found in nearly all water of the lake having depths between 0.75 and 3 meters (2.5 and 10 feet). The dense growth restricts boating, swimming, and fishing activities" (Jones, 1986). Visual sampling was conducted by Aquatic Control Inc. prior to several treatments in 2004 (Figure 4 & 5). Eurasian watermilfoil (*Myriophyllum spicatum*) was the most abundant species present during the pre-treatment sampling. Small pondweed (*Potamogeton pusillus*), American pondweed (*Potamogeton nodosus*), American water willow (*Justica americana*), spatterdock (*Nuphar spp.*), American lotus (*Nelumbo lutea*), slender naiad (*Najas flexilis*), curlyleaf pondweed (*Potamogeton crispus*), and coontail (*Ceratophyllum demersum*) were also present during the pre-treatment sampling. Appendix A documents species which have been sampled over the past 20 years.

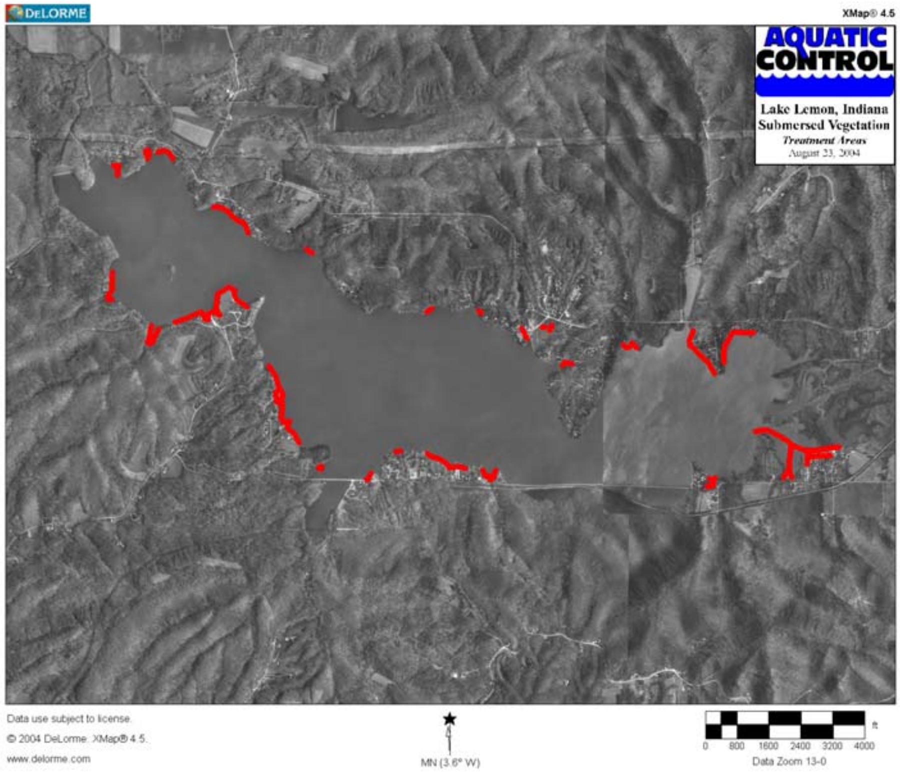


Figure 4. Lake Lemon, 2004 submersed vegetation treatment and sampling areas (not to scale see appendix)

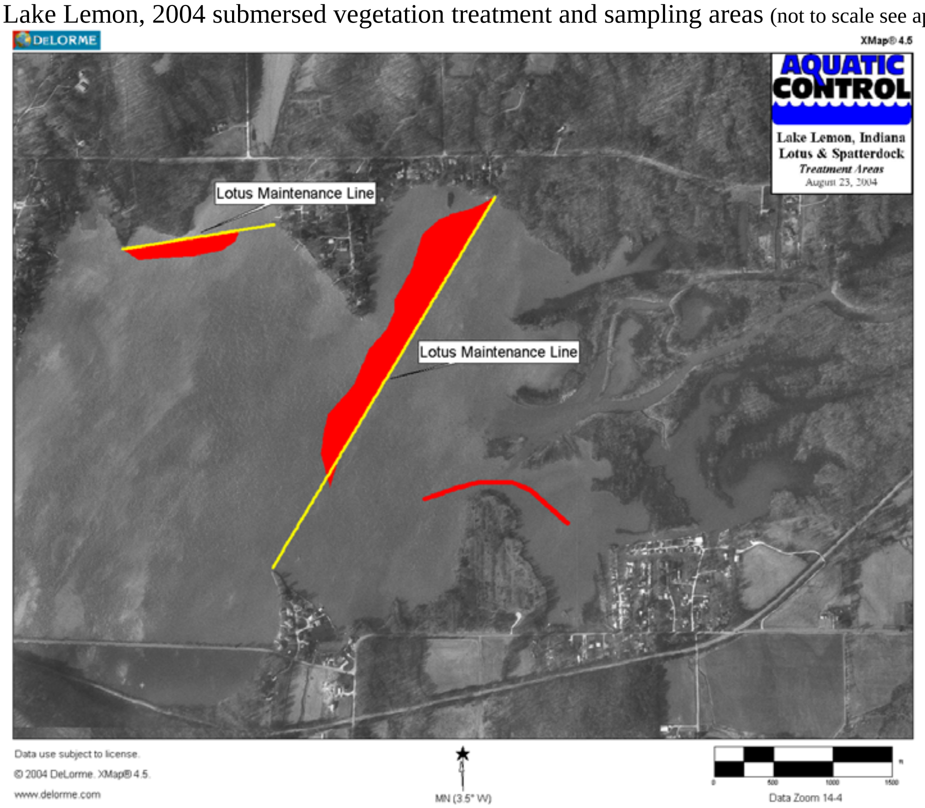


Figure 5. Lake Lemon lotus and spatterdock treatment and sampling areas (not to scale see appendix)

Tier I and Tier II sampling was completed on Lake Lemon on August 23, 2004. Ideally, two Tier II surveys should be completed in a season in order to document changes in plant community characteristics that occur over the course of the spring through late summer seasons, but due to time limitations a single survey was completed in 2004.

Tier I Survey
The Tier I survey was developed to serve as a qualitative surveying mechanism for aquatic plants. The Tier I survey is based upon the procedure manual developed by Shuler & Hoffmann, 2002. This survey will serve to meet the following objectives:

1. to provide a distribution map of the aquatic plant species within a waterbody
2. to document gross changes in the extent of a particular plant bed or the relative abundance of a species within a waterbody (IDNR, 2004)

The Tier I survey revealed eight distinct plant beds within Lake Lemon totaling 307 acres. (Table 2 & Figure 6). Vegetation was present to a maximum depth of 5 feet. Plant beds varied widely in size and species diversity. Eurasian watermilfoil was present in all plant beds.

Table 2. Tier I Survey Results

Plant Bed I.D.	#1	#2	#3	#4	#5	#6	#7	#8
Plant Bed Size (acres)	57.37	9.62	112.74	5.29	50.67	17.93	52.24	1.22
	Rating*	Rating*	Rating*	Rating*	Rating*	Rating*	Rating*	Rating*
Eurasian watermilfoil**	2	2	2	2	2	2	2	2
American water willow	2	1	1	-	-	-	1	-
Coontail	-	2	2	2	2	1	1	-
Brittle naiad	1	1	1	1	-	-	1	3
Spatterdock	-	-	2	2	1	2	1	-
American Lotus	1	1	4	2	2	4	1	-
American pondweed	1	-	1	-	-	-	1	-
Sago pondweed	1	1	1	-	-	-	-	-
Small pondweed	-	-	-	-	-	-	-	1
American elodea	-	1	-	1	-	-	-	-
Chara	-	-	-	-	1	-	1	-
Curlyleaf Pondweed**	-	-	1	-	1	-	1	-
Watermeal	-	-	-	1	-	-	-	-

*rating based on score of 1-4 with 1 being least abundant and 4 being most abundant
**exotic species

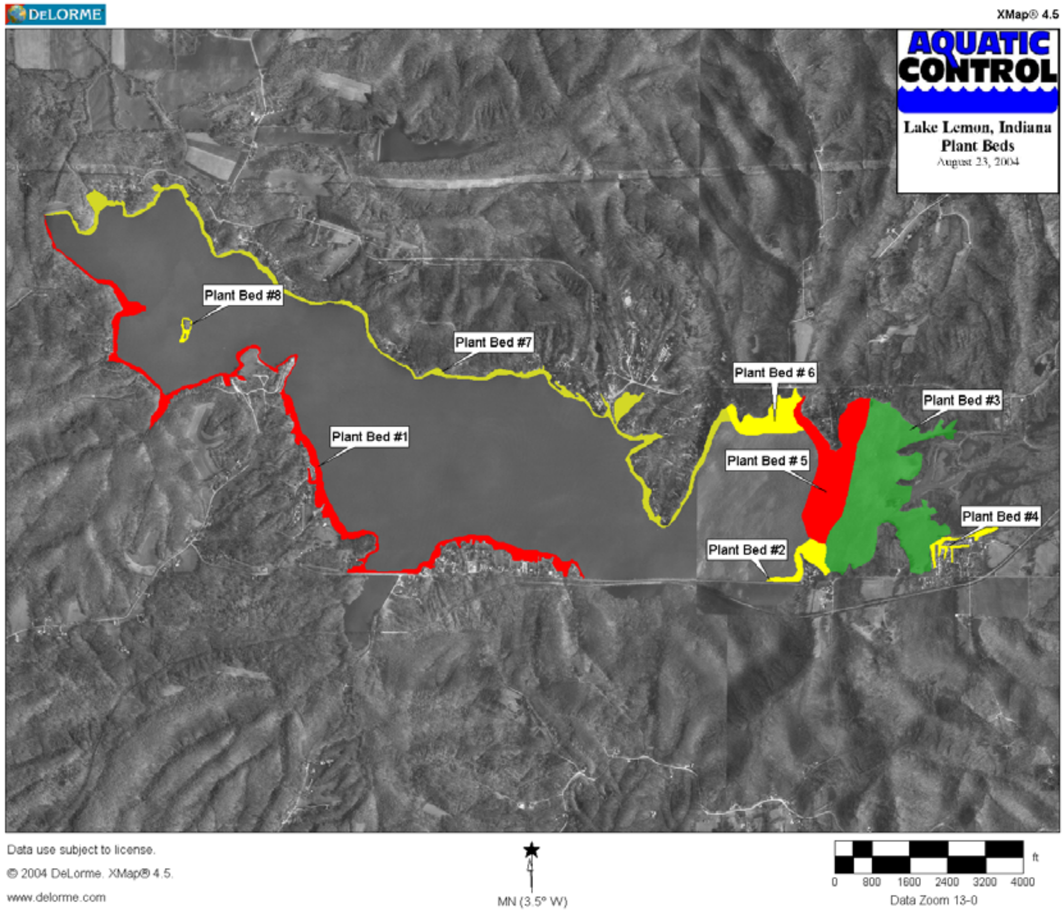


Figure 6. Tier I Plant Beds, Lake Lemon, August 20, 2004 (not to scale see appendix)

Plant bed 1 was determined to be 57.37 acres in size. This plant bed included the entire littoral area on the southern side of the lake from the dam to the furthest east causeway (Figure 6). The substrate of plant bed 1 was predominantly sand with silt. A total of 6 species were observed within the plant bed. Eurasian watermilfoil and American water willow were the dominant plant species (2-20% abundance rating). American lotus, brittle naiad (*Najas minor*), sago pondweed (*Potomogeton pectinatus*), and American pondweed (*Potamogeton nodosus*) were present at the lowest abundance rating (less than 2%). This area has historically been dominated by Eurasian watermilfoil, but during 2004 several spot treatments with triclopyr herbicide were completed to selectively control this species.

Plant bed 2 was located east of the causeway and determined to be 9.62 acres (Figure 6). The substrate of plant bed 2 was sand with silt. A total of 7 species were observed within the plant bed. Eurasian watermilfoil and coontail were the dominant species (2-20% abundance rating). American pondweed, American water willow, brittle naiad, American elodea (*Elodea canadensis*), and American lotus were present at the lowest abundance rating (less than 2%).

Plant bed 3 was located in the shallow upper end of the lake and was determined to be 112.74 acres (Figure 6). The substrate of plant bed 3 was silt/clay and high in organics.

A total of 7 species were observed within the plant bed. American lotus was the most abundant species observed (greater than 60% abundance rating). Spatterdock, Eurasian watermilfoil, and coontail were present at 2-20% abundance. American water willow, American pondweed, brittle naiad, curlyleaf pondweed, and sago pondweed were present at the lowest abundance rating (less than 2%). Greater than 60% of the plant bed was dominated by canopy forming vegetation.

Plant bed 4 encompassed the channel area known as the Chitwood Addition (Figure 6). This plant bed was determined to be 5.29 acres. The substrate of plant bed 4 was silt/clay and high in organics. A total of 7 species were observed within the plant bed. Eurasian watermilfoil, coontail, spatterdock, and American lotus were the most abundant species observed (2-20% abundance rating). Watermeal (*Wolfia spp.*), brittle naiad, and American elodea were present at less than 2% abundance. This area receives regular herbicide applications in order to provide residents of the Chitwood Addition navigable boating lanes.

Plant bed 5 was located just west of plant bed 4 (Figure 6). This plant bed was determined to be 50.67 acres. The substrate of plant bed 5 was silt/clay and high in organics. A total of 6 species were observed within the plant bed. Eurasian watermilfoil, coontail, and American lotus were the most abundant species observed (2-20% abundance rating). Chara (*Chara spp.*), curlyleaf pondweed, and spatterdock were present at less than 2% abundance.

Plant bed 6 was located on the north shore of Lake Lemon just west of plant bed 5 (Figure 6). This plant bed was determined to be 17.93 acres. The substrate of plant bed 6 was silt/clay and high in organics. A total of 4 species were observed within the plant bed. American lotus was the most abundant species observed (greater than 60% abundance rating). Eurasian watermilfoil and spatterdock were present at less than 2-20% abundance. Coontail was present at only 2% abundance.

Plant bed 7 was located on the north shore of Lake Lemon just west of plant bed 6 and ended near the dam (Figure 6). This plant bed was determined to be 52.24 acres. The substrate of plant bed 7 was silt with sand. A total of 9 species were observed within the plant bed. Eurasian watermilfoil was the most abundant species observed (2-20% abundance rating). American water willow, American pondweed, American Lotus, coontail, chara, brittle naiad, spatterdock, and curlyleaf pondweed were present at only 2% abundance.

Plant bed 8 included the littoral area around the islands located west of Riddle Point Park (Figure 6). This plant bed was determined to be 1.22 acres. The substrate of plant bed 7 was silt with sand. A total of 3 species were observed within the plant bed. Brittle naiad was the most abundant species observed (21-60% abundance rating). Eurasian watermilfoil was present at a 2-20% abundance rating and small pondweed had a less than 2% rating.

Tier II Survey

Creation of the aquatic vegetation management plan also requires sampling to quantify the occurrence, distribution, and abundance aquatic vegetation. This type of survey will be referred to as the Tier II survey. This protocol is currently being used by the IDNR Division of Fish and Wildlife to provide a quantitative sampling mechanism for aquatic plant surveying. This protocol supplements the Tier I Reconnaissance Protocol for plant bed mapping. Together the protocols should serve to meet the following objectives:

1. to document the distribution and abundance of submersed and floating-leaved aquatic vegetation
2. to compare present distribution and abundance with past distribution and abundance within select areas (IDNR, 2004).

All of the data which was collected through the use of this protocol was recorded on standardized data sheets. The data collected was compared to data collected by district fisheries biologist Jed Pearson, which is presented in his 2004 paper "A Sampling Method to Assess Occurrence, Abundance, and Distribution of Submersed Aquatic Plants in Indiana Lakes". In this paper, Pearson used 21 northern Indiana lakes to calculate various aquatic plant abundance and diversity metrics. The sampling procedure outlined in Pearson's paper was used to calculate these same metrics for Lake Lemon (Table 3). The data collected will also be valuable for future comparison, which will document changes in the plant community following proposed management activities.

A predetermined number of sites were randomly selected throughout the littoral zone (the number of sites is dependent on lake size). Once a site was reached the boat was slowed to a stop and the coordinates were recorded on a hand-held GPS unit and later downloaded into a mapping program. A depth measurement was taken by dropping a two-headed standard sampling rake that was attached to a rope marked off in 1-foot increments (Figure 7). An additional ten feet of rope was released and the boat was reversed at minimum operating speed for a distance of ten feet. Once the rake is retrieved the overall plant abundance on the rake is scored from 1-5 and then individual species are placed back on the rake and scored separately (the rake is marked off in 5 equal sections on the tines).

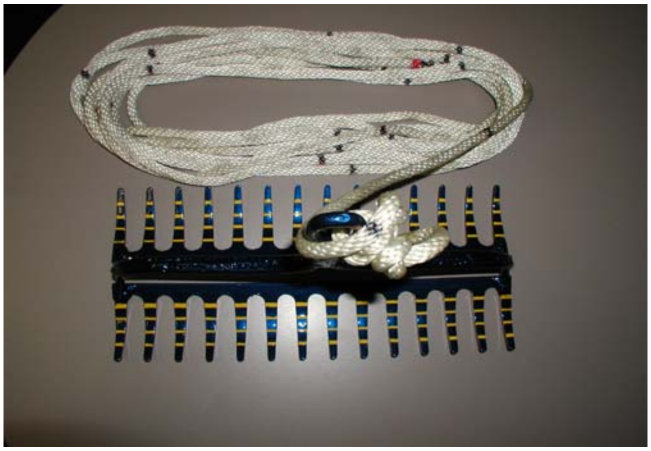


Figure 7. Sampling Rake

Tier II sampling took place on August 23, 2004 immediately following the Tier I sampling. A Secchi disk reading was taken prior to sampling and was found to be 2 feet. Plants were present to a maximum depth of 5 feet. Two hundred littoral zone sites were sampled (Figure 8). The mean depth from which samples were taken was 3.54 feet. The mean rake density score for Lake Lemon was 1.69. Species richness (average number of species per site) was 1.14 for all species and 0.59 for natives only. Site species diversity index was 0.72 for all species and 0.71 for native species only. Lake Lemon had a rake diversity score of 0.69 for all species and 0.66 for natives only (Table 3). Submersed vegetation distribution and density is illustrated in Figure 9.

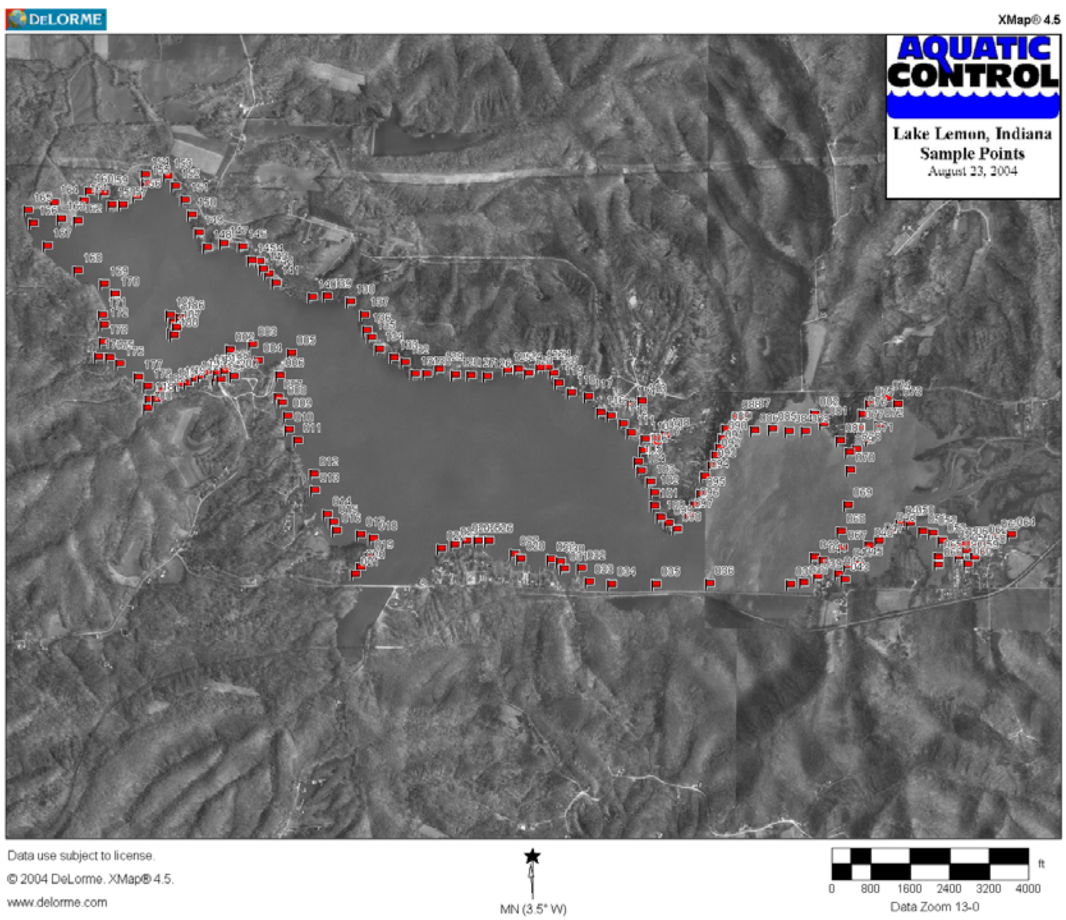


Figure 8. Tier II Sample Points (not to scale see appendix)

Table 3. Lake Lemon vegetation abundance, density, and diversity metrics compared to average

	Lake Lemon*	Average**
Percentage of littoral sites with vegetation	74%	-
# of species collected	10	8
# of native species collected	8	7
Mean Rake Density	1.69	3.30
Rake Diversity (SDI)	0.69	0.62
Native Rake Diversity (SDI)	0.66	0.50
Species Richness (Avg # spec./site)	1.14	1.61
Native Species Richness	0.59	1.33
Site Species Diversity	0.72	0.66
Site Species native diversity	0.71	0.56

*standard deviation not included
**average calculated from Pearson Data.

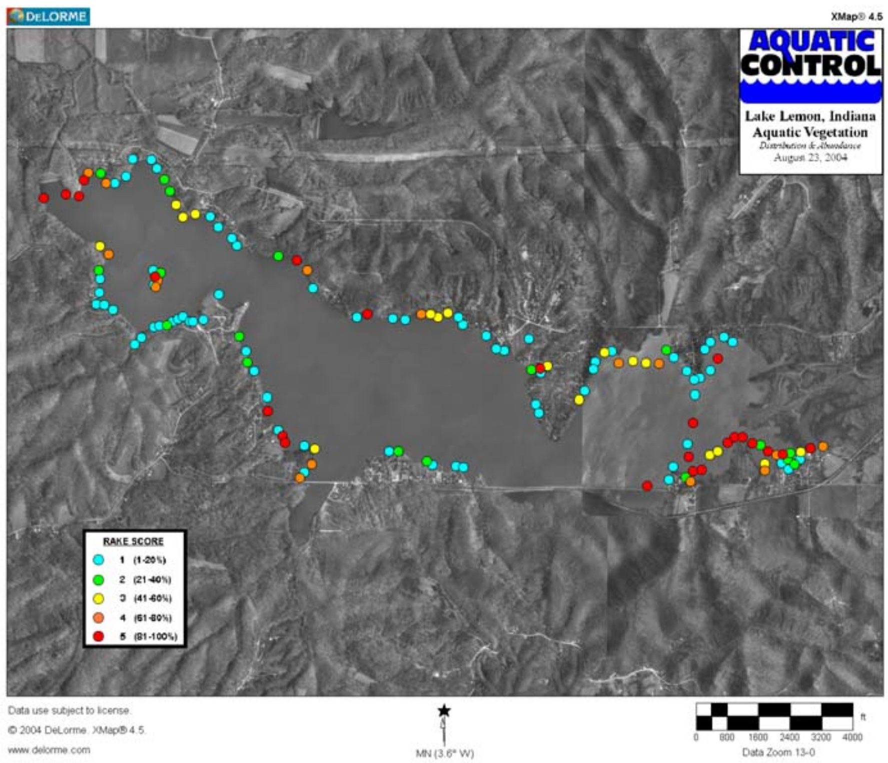


Figure 9. Aquatic vegetation distribution and abundance (not to scale see appendix)

Frequency of occurrence, relative density, and dominance indices for individual species are illustrated in Table 4. A total of 10 species were collected of which 8 of the species were natives. Eurasian watermilfoil and curlyleaf pondweed were the exotic species collected. Eurasian watermilfoil was present in the highest percentage of sample sites (51.5%) (Figure 10), followed by coontail (26.0%) (Figure 11), brittle naiad (15.0%), small pondweed (6.5%) (Figure 12), chara (5.0%) (Figure 13), curlyleaf pondweed (3.5%), American elodea (3.5%), American pondweed (1.5%). Horned pondweed and American lotus were collected at a single site (Table 2).

Table 4. Species collected during Tier II sampling.

Common Name	Scientific Name	Frequency of Occurrence	Relative Density*	Dominance Index**
Eurasian watermilfoil	*Myriophyllum spicatum*	51.5%	0.96	19.2
Coontail	*Ceratophyllum demersum*	26.0%	0.53	10.6
Brittle naiad	*Najas minor*	15.0%	0.26	5.1
Small pondweed	*Potamogeton pusillus*	6.5%	0.08	1.5
Chara	*Chara spp.*	5.0%	0.07	1.3
Curlyleaf pondweed	*Potamogeton crispus*	3.5%	0.04	0.8
American elodea	*Najas flexilus*	3.5%	0.07	1.4
American pondweed	*Potamogeton nodosus*	1.5%	0.02	0.4
Horned pondweed	*Zannichellia palustris*	0.5%	0.01	0.1
American lotus	*Nelumbo lutea*	0.5%	0.01	0.1

*Mean rake score at all sites
**Percent of maximum abundance

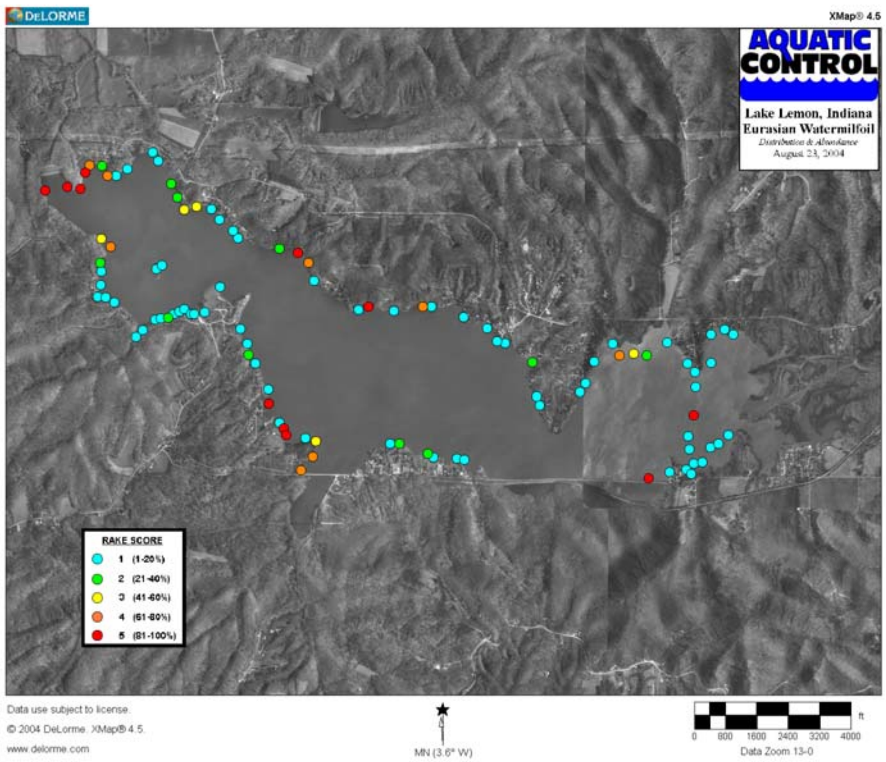


Figure 10. Eurasian watermilfoil distribution and abundance (not to scale see appendix)

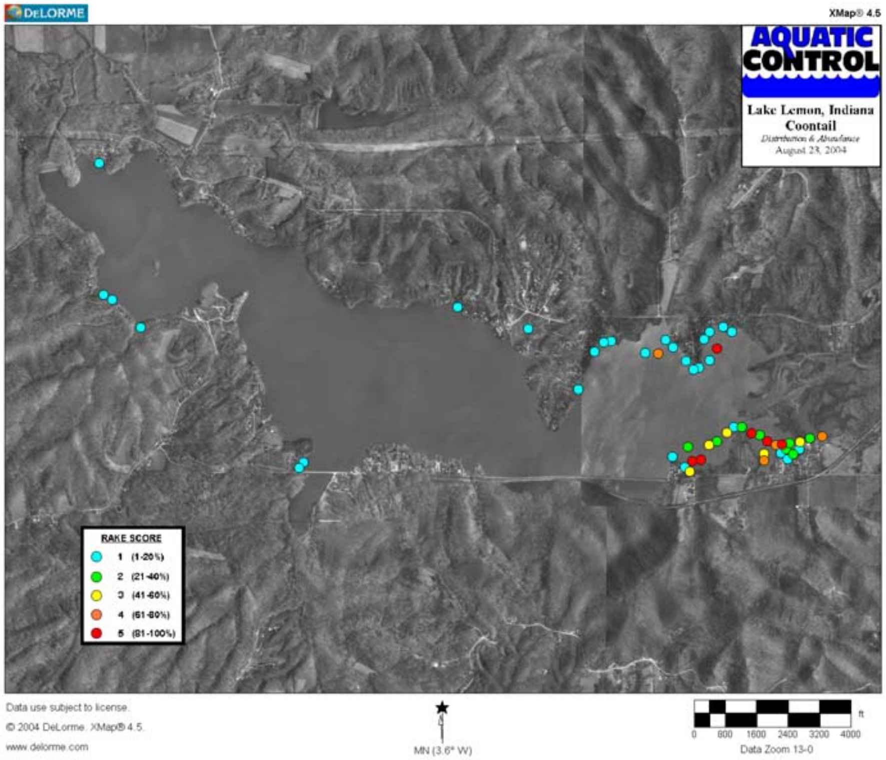


Figure 11. Coontail distribution and abundance (not to scale see appendix)

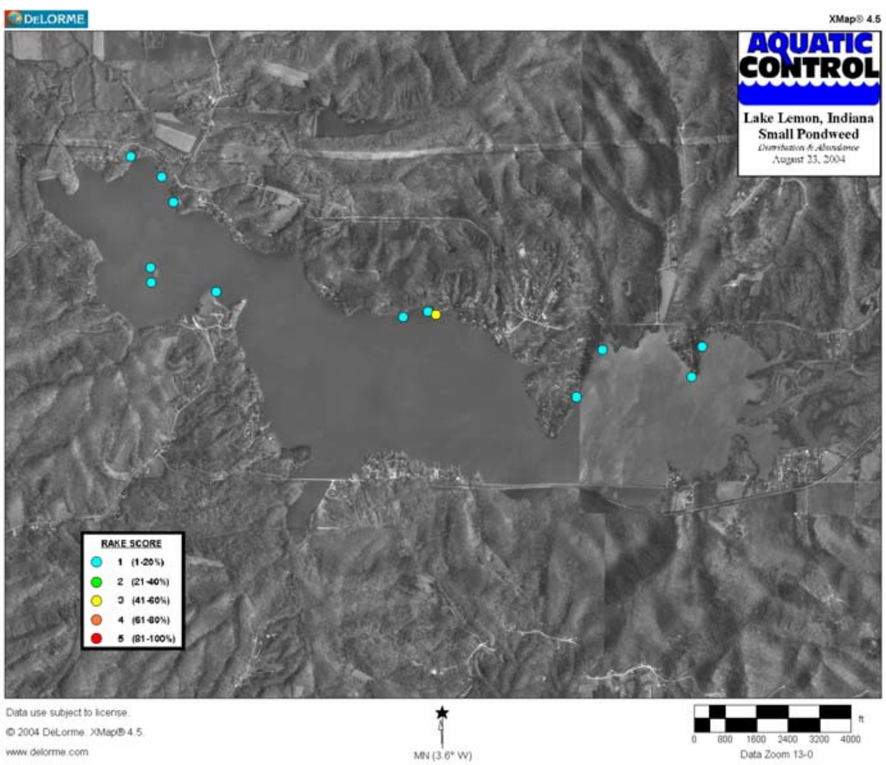


Figure 12. Small Pondweed distribution and abundance (not to scale see appendix)

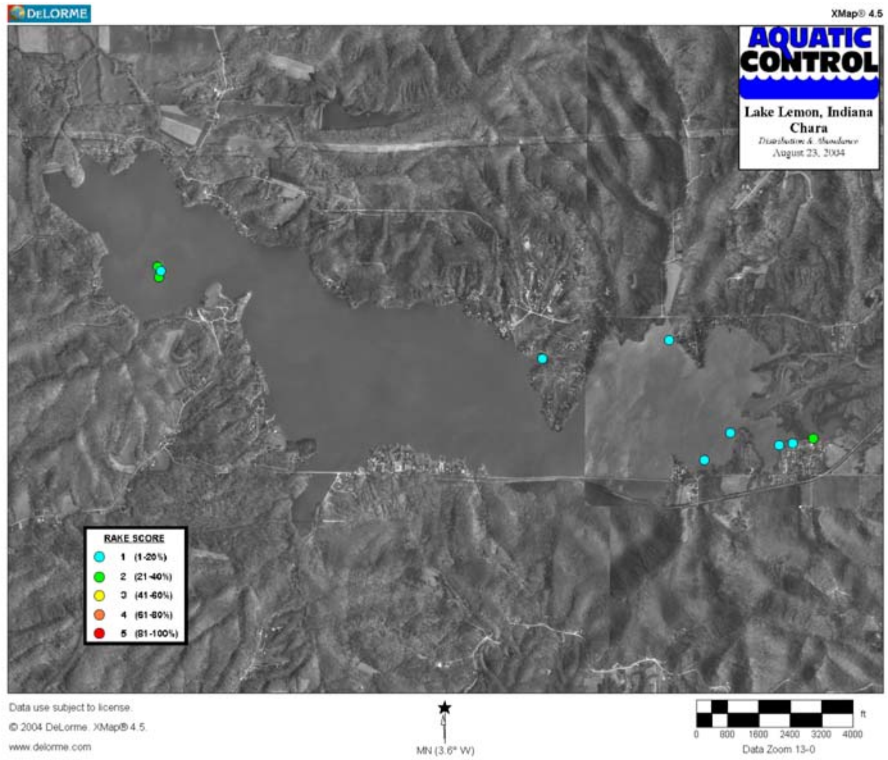


Figure 13. Chara distribution and abundance (not to scale see appendix)

Plant Management History

Lake Lemon has a long history of Aquatic Vegetation Management (Table 5). The main target of plant management activities has been Eurasian watermilfoil. However, purple loosestrife (*Lythrum salicaria*), American lotus, spatterdock, slender naiad, and fine-leaved pondweeds have also been targets of management activities.

Table 5. Lake Lemon Treatment History

Year	Treatment Activity
1979	400 acres of Eurasian watermilfoil and coontail treated with endothal.
1996	5 acres of American Lotus treated with glyphosate & 33 acres of Eurasian watermilfoil treated with endothal
1997	20 acres of American Lotus treated with glyphosate & 53 acres of Eurasian watermilfoil treated with endothal
1998	20 acres of American Lotus treated with glyphosate & 53 acres of Eurasian watermilfoil treated with endothal
1999	20 acres of American Lotus treated with glyphosate
2000	20 acres of American Lotus treated with glyphosate & 53 acres of Eurasian watermilfoil treated with endothal
2001	20.5 acres of American Lotus treated with glyphosate & 72 acres of Eurasian watermilfoil treated with endothal*
2002	32 acres of American Lotus and spatterdock treated with glyphosate & 106 acres of Eurasian watermilfoil treated with endothal*
2003	18 acres of American Lotus and spatterdock treated with glyphosate & 76.5 acres of Eurasian watermilfoil treated with triclopyr
2004	8 acres of American Lotus and spatterdock treated with glyphosate & 127.25 acres of Eurasian watermilfoil and mixed pondweeds treated with triclopyr and endothal**

* Total acres includes areas which were treated multiple times due to regrowth

**Total acres includes areas where pondweeds created nuisance conditions following triclopyr treatment

A herbicide treatment of approximately 400 acres of Eurasian watermilfoil was completed in 1979 by Aquatic Control Inc. for the Bloomington Parks and Recreation Department. Eurasian watermilfoil and coontail covered an estimated 70% of the lake at this time. The treatment was considered a success (Bob Johnson, personal communication). No treatment records are available between 1979 and 1996, and it is believed that no management activity took place during this period.

The Lake Lemon Conservancy District was formed in 1995 and this led to an increase in management activities. A harvester was purchased by the LLCD in the late 1990's and was used to harvest aquatic vegetation that was immediately interfering with boat navigation, dock access, or recreation. The harvester was recently sold. Manual harvest of purple loosestife has also taken place. This exotic species has been documented at low abundance along some residential shorelines.

Aquatic Control Inc. completed herbicide treatments from 1996 through 2004 for control of Eurasian watermilfoil, lotus, and spatterdock. Eurasian watermilfoil treatments were limited to areas where Eurasian watermilfoil was impeding boating or dock access. Endothal (trade name Aquathol K) was used for Eurasian watermilfoil control from 1996-2002. In 2003, a new herbicide named triclopyr (trade name Renovate) was approved for aquatics. This herbicide exhibited great control and selectivity for Eurasian watermilfoil and has been applied in 2003 and 2004 for selective control of Eurasian watermilfoil once it reached nuisance levels (Figure 3). Several treatments with triclopyr were completed in 2003 and 2004. Endothal was used on a limited basis in 2004 when native pondweeds began creating nuisance conditions. It is believed that selective control of Eurasian watermilfoil with triclopyr reduced competition and allowed native pondweeds to flourish causing nuisance conditions in and around some dock areas.

From 1996-2004, Glyphosate was applied in the east end of the lake to control selected areas of American lotus and spatterdock (Figure 4). The district fisheries biologist and the LLCD manager have established maintenance lines where American lotus will be treated if it occurs outside these lines. Spatterdock and American lotus were also treated in order to maintain a boat lane connecting the Chitwood Addition to the main lake. Herbicide application from 1996-2004 are summarized below in Table 4.

In addition to herbicide applications and harvesting, lake drawdown has been used in an attempt at reducing nuisance conditions created by Eurasian watermilfoil. Every fall the LLCD attempts to manipulate water levels by use of a sluice gate. However, due to the lake's large watershed compared to lake volume, it is difficult to remove enough water to effectively control vegetation. This management technique has been effective on the single occasion where the lake was adequately drawn down for and extended period of time.

Aquatic Plant Management Alternatives

Three exotic species are present in Lake Lemon; curlyleaf pondweed, purple loosestrife, and Eurasian watermilfoil. Eurasian watermilfoil is the only exotic species which has created nuisance conditions. It is believed that Eurasian watermilfoil was first introduced from Eurasia or North Africa to an area near Maryland around 1942, possibly through the aquarium trade. Some reports suggest that this species may have been introduced into North America as early as the late 1800's through shipping ballast (Ditomaso & Healy, 2003). This species has now spread throughout the majority of North America and is the primary nuisance submersed aquatic species in Indiana. Once established, growth and physiological characteristics of Eurasian watermilfoil enable it to form a surface canopy and develop into immense stands of weedy vegetation, out competing most submersed species and displacing the native plant community (Madsen et al., 1988).

Steps need to be taken in order to prevent Eurasian watermilfoil from reaching these dense levels. The Lake Lemon Conservancy District has been able to raise enough funds to limit Eurasian watermilfoil growth in developed areas, but additional funding is needed to more aggressively pursue this species and reduce the need for multiple annual treatments in Lake Lemon. In order to develop a scientifically sound and effective action plan for control of Eurasian watermilfoil, all aquatic management alternatives need to be considered. The alternatives that will be discussed include: no action; environmental manipulation; chemical, mechanical, or biological control methods; and any combination of these methods.

A number of different techniques have been successfully used to control Eurasian watermilfoil. These techniques vary in terms of their efficacy, rapidity, and selectivity, as well as the thoroughness and longevity of control they are capable of achieving. Each technique has advantages and disadvantages, depending on the circumstances. Selectivity is a particularly important characteristic of control techniques. Nearly all aquatic plant control techniques are at least somewhat selective, in that they affect some plant species more than others. Even techniques such as harvesting that have little selectivity within the areas to which they are applied can be used selectively, by choosing only certain areas in which to apply them. Selectivity can also occur after the fact, as when a technique controls all plants equally but some grow back more rapidly. One facet of selecting an appropriate aquatic plant control technique is matching the selectivity of the control technique with the goals of aquatic plant management. When controlling Eurasian watermilfoil, for example, it is typically desirable to use techniques that control Eurasian watermilfoil with minimal impact on most native species (Smith, 2002). A summary of the advantages and disadvantages of each control technique is listed in Table 6.

No Action

What if no aquatic plant management activity took place on Lake Lemon? This was the case prior to 1979 and Eurasian watermilfoil was present in dense monoculture stands which covered over 75% of the lake, so it is feasible to believe this could be the case if no action was taken. Eurasian watermilfoil would most likely return to pre-1979 levels within 3-6 years if management activity ceased.

Environment manipulation
Environmental manipulation for Lake Lemon would include water level draw-down. Successful use of water draw-down for controlling Eurasian watermilfoil typically requires drawing down water levels sufficiently to expose the entire Eurasian watermilfoil population. This technique can be effective if the drawdown exposes the entire Eurasian watermilfoil population to freezing and thawing, however drawdown can result in the expansion of Eurasian watermilfoil into deeper water. Drawdown can also have negative affects on native plant species. Draw-down has been used as a management technique for several years on Lake Lemon. The effects of the draw-down is not clear due to the lack of a control (draw-down has taken place for many consecutive years and there is no sampling data available from years which a draw-down did not occur). Despite the lack of data, it is our recommendation that the draw-down continue due to the possibility that it may be having positive effects on reducing the density of Eurasian watermilfoil.

Mechanical
Mechanical control includes cutting, dredging, or tilling the bottom sediments to eliminate aquatic plant growth. The main advantage to mechanical control is the immediate removal of the plant growth from control areas and the removal of organic matter and nutrients.

One of the most common mechanical control techniques used on larger lakes in Indiana is mechanical harvesting. Mechanical harvesting uses machines which cut plant stems and, in most cases, pick up the cut fragments for disposal. This type of mechanical control has little selectivity. Where a mix of Eurasian watermilfoil and native species exists, harvesting favors the plant species that grow back most rapidly following harvesting. In most cases, Eurasian watermilfoil recovers from harvesting much more rapidly than native plants. Thus, repeated harvesting hastens the replacement of native species by Eurasian watermilfoil and often leads to dense monocultures of Eurasian watermilfoil in frequently harvested areas. Harvesting also stirs up bottom sediments thus reducing water clarity, kills fish and many invertebrates, and hastens the spread of Eurasian watermilfoil via fragmentation. In the past, the LLCD has used this technique for control of Eurasian watermilfoil and American lotus. This control technique has not been used for several years by the LLCD, and it is not recommended for future control of Eurasian watermilfoil.

Residents of Lake Lemon have used a smaller scale harvesting technique by using a rake specifically designed for cutting and removing submersed vegetation. These rakes have been purchased by the LLCD and are made available to residents experiencing nuisance vegetation problems in and around their dock areas. Residents should keep in mind that only a 625 square foot area can be harvested without obtaining a permit from IDNR.

Biological
Biological controls reduce aquatic vegetation using other organisms that consume aquatic plants or cause them to become diseased (Smith, 2002). The main biological controls for Eurasian watermilfoil used in Indiana are the white amur (grass carp) and the milfoil weevil.

The white amur or grass carp *Ctenopharyngodon idella* is a herbivorous fish imported from Asia. Triploid grass carp, the sterile genetic derivative of the diploid grass carp, are legal for use in Indiana. Grass carp tend to produce all or nothing aquatic plant control. It is very difficult to achieve a stocking rate sufficient to selectively control nuisance species without eliminating all submersed vegetation. They are not particularly appropriate for Eurasian watermilfoil control because Eurasian watermilfoil is low on their feeding preference list; thus, they eat most native plants before consuming Eurasian watermilfoil (Smith, 2002). Grass carp are also difficult to remove from a lake once they have been stocked. Grass carp are not recommended for Eurasian watermilfoil control.

The milfoil weevil, *Euhrychiopsis lecontei,* is a native North American insect that consumes Eurasian and Northern watermilfoil. The weevil was discovered following a natural decline of Eurasian watermilfoil in Brownington Pond, Vermont (Creed and Sheldon, 1993), and has apparently caused declines in several other water bodies. Weevil larvae burrow in the stem of Eurasian watermilfoil and consume the vascular tissue thus interrupting the flow of sugars and other materials between the upper and lower parts of the plant. Holes where the larvae burrow into and out of the stem allow disease organisms a foothold in the plants and allow gases to escape from the stem, causing the plants to lose buoyancy and sink (Creed et al. 1992).

Concerns about the use of the weevil as a biological control agent relate to whether introductions of the milfoil weevil will reliably produce reductions in Eurasian watermilfoil and whether the resulting reductions will be sufficient to satisfy users of the lake (Smith, 2002). Following our research, no conclusive data concerning the role of weevils in reducing Eurasian watermilfoil populations has been made available. In 2003, Scribailo & Alix conducted a weevil release study on three Indiana lakes and had no conclusive evidence supporting the use of weevils in reducing milfoil populations. Weevils may reduce milfoil populations in some lakes, but predicting which lakes and how much, if any, control will be achieved has not been documented.

Chemical Control
Chemical control uses chemical herbicides to reduce or eliminate aquatic plant growth. The main advantage of using herbicides is their overall effectiveness. The publics main concern over herbicide use is safety. This should not be a concern due to the extensive testing which is required prior to herbicide being approved for use in the aquatic environment. These tests ensure that the herbicides are low in toxicity to human and animal life and they are not overly persistent or bioaccumulated in fish or other organisms.

There are two different types of aquatic herbicides; systemic and contact. Systemic herbicides are translocated throughout the plants and thereby kill entire plants. Fluridone (trade name Sonar & Avast!), 2,4-D (trade name Navigate, Aqua-Kleen, & DMA4 IVM), and trichlopyr (trade name Renovate) are systemic herbicides that can effectively control Eurasian watermilfoil.

Based upon the author's experience and personal communication with a vast array of North American aquatic plant managers, whole-lake fluridone applications are by far the most effective means of controlling Eurasian watermilfoil. Successful fluridone treatments yield a dramatic reduction in the abundance of Eurasian watermilfoil, often reducing it to the point that Eurasian watermilfoil plants are difficult to detect following treatment (Smith, 2002). An advantage to using fluridone over most contact herbicides is its selectivity. Most strains of Eurasian watermilfoil have a lower tolerance to fluridone than the majority of native species, so if the proper rates are applied Eurasian water milfoil can be controlled with little harm to the majority of native species.

Triclopyr is a systemic herbicide that has recently been approved for use in aquatics. Triclopyr typically is used for treating isolated milfoil beds as opposed to whole lake treatments. This herbicide is very selective to Eurasian watermilfoil. A study was completed which analyzed the effects of triclopyr on Eurasian watermilfoil and native vegetation. The study found Eurasian watermilfoil biomass was reduced by 99% in treated areas at 4 weeks post-treatment, remained low one year later, and was still at acceptable levels of control at two years post-treatment. Non-target native plant biomass increased 500-1000% by one year post-treatment, and remained significantly higher in the cove plot at two years post-treatment. Native species diversity doubled following herbicide treatment, and the restoration of the community delayed the re-establishment and dominance of Eurasian watermilfoil for three growing season (Getsinger et. al., 1997). Triclopyr is a good alternative to fluridone when Eurasian watermilfoil is not abundant throughout an entire water body. This herbicide has been used in Lake Lemon for Eurasian watermilfoil control in 2003 and 2004. It has effectively controlled milfoil and caused a dramatic increase in native vegetation within treatment areas to the point where native vegetation reaches nuisance levels. Long-term control of Eurasian watermilfoil with triclopyr herbicide has not occurred on Lake Lemon. This is due to the treatment strategy which focuses on soley treating areas where Eurasian watermilfoil has reached nuisance levels. This leads to quick reintroduction from untreated areas. If longer term control is desired, Eurasian watermilfoil must be treated everywhere it occurs in the lake.

Applied properly, 2,4-D can also yield major reductions in the abundance of Eurasian watermilfoil, but long-term reductions are more difficult to achieve using 2,4-D than using whole-lake fluridone applications. Treatments must be even and dose rates accurate. Under the best circumstances, some areas will probably need to be treated repeatedly before the Eurasian watermilfoil in them is controlled. Also, the difficulty of finding and treating areas of sparse Eurasian watermilfoil makes it likely that Eurasian watermilfoil will be reestablished from plants surviving in these areas (Smith 2002). This formulation should be used much like Triclopyr, but the same results may not occur.

Unlike Triclopyr, 2,4-D can impact the native species coontail. This herbicide is not approved for use in Lake Lemon due to drinking water restrictions.

Contact herbicides can also be effective for controlling submersed vegetation in the short term. The three primary contact herbicides used for control of submersed vegetation are diquat (trade name Reward), endothal (trade name Aquathol), and copper based formulations (trade names Komeen, Nautique, and Clearigate).

Historically, a drawback to the use of contact herbicides has been the lack of selectivity exhibited by these herbicides. However, a study recently completed by Skogerboe and Getsinger in 2002 outlines how endothal can be used for control of the exotic species curlyleaf pondweed and Eurasian watermilfoil with little effect on the majority of native species. They found early season treatments with endothall effectively controlled Eurasian watermilfoil and curlyleaf pondweed at several application rates with no regrowth eight weeks after treatment. Sago pondweed, eel grass, and Illinois pondweed biomass were also significantly reduced following the endothall application, but regrowth was observed at eight weeks post-treatment. Coontail and elodea showed no effects from endothall at three of the lower application rates. Spatterdock, pickerelweed, cattail, and smartweed were not injured at any of the application rates (Skogerboe & Getsinger 2002). This type of treatment strategy could be applied to lakes that have large areas of both curlyleaf pondweed and Eurasian watermilfoil. Endothal could also be effective the year after whole lake fluridone treatments where curlyleaf pondweed typically returns the following season. Endothal has been used for many years in Lake Lemon for control of Eurasian watermilfoil and mixed pondweeds. Results have been mixed, but this may be due to the limited areas which were treated resulting in reinfestation from untreated areas of the lake. This herbicide should still be considered as an effective tool for control of areas with nuisance pondweed growth mixed with Eurasian watermilfoil.

Diquat and many of the copper formulations are effective fast acting contact herbicides. These formulations are typically used when control of all submersed vegetation is desired. These herbicides are commonly used for control of nuisance vegetation around docks and near-shore high-use areas. These herbicides are not selective and plants can often times recover in 4-8 weeks after treatment. Diquat herbicide is a good tool for control of naiad species if they reach nuisance levels. However, diquat does not perform well in turbid water thus limiting its effectiveness in Lake Lemon.

Table 6. Summary of aquatic vegetation control methods.

Control Method	Advantages	Disadvantages	Conclusion
No Action	No cost and less controversy	No plant control, degradation of fish habitat, difficult boating, and spread of exotic plant species.	Something should be initiated to prevent spread of milfoil and reduce nuisance conditions.
Environmental Manipulation (drawdown)	Low cost, compaction of flocculent sediments, may get control of some nuisance species, and less controversial.	Unpredictable plant control, exposes desirable plants and animals to freezing and thawing, dependent on good freeze, could impede recreation, dependent on spring rains to raise water level or lack of precipitation in winter to lower water level.	Has been used effectively on occasion, but difficult to lower water level sufficiently to expose nuisance areas. Should be continued due to low cost and potential benefit, but may not meet with great success.
Mechanical (cutting, dredging, or tilling)	Low cost, less controversy, can target areas of desired control, removes organics.	Possibility of spreading exotic vegetation, labor intensive, damage to fish and other aquatic organisms, and harvesting can promote increased milfoil growth.	Not good option due to potential spread of exotics. Could possibly be used on small-scale initial infestation or post-treatment.
Biological Control (milfoil weevil)	No chemical needed, naturally occurring native species, no use restrictions following application, selective for Eurasian watermilfoil, and known to cause fatal damage to plant	Studies have been inconclusive on the effectiveness and cost is relatively high compared to most other control methods.	No proof that this method is effective. Too large of an investment for unproven method.
Biological Control (Grass Carp)	No chemical needed, no use restrictions following application, no reproduction, and proven to consume aquatic vegetation.	Prefers many of the native species over exotic species, non-native fish species, tend to move downstream, once they are introduced they are nearly impossible to remove.	Not a good option due to inability to remove once stocked and preference for native vegetation.
Chemical Control	Proven safe and effective technique, can be selective, relatively easy application, and fast results.	Higher cost than most techniques, public concern over chemicals, build-up of dead plant material following application, and lake use restrictions	Proven to be effective with minimal use restrictions very effective Eurasian watermilfoil control

Action Plan

The focus of the action plan should be the control of invasive exotic plant species. These species include Eurasian watermilfoil, purple loosestrife, and curlyleaf pondweed. Currently, mechanical removal of purple loosestrife appears to be effective and curlyleaf pondweed, to our knowledge, has never reached nuisance conditions (this species should be closely monitored with future plant surveys). The 2004 sampling discovered Eurasian watermilfoil at 51.5% of sample sites. Due to a limited budget, the current management strategy involves application of triclopyr herbicide only to areas where Eurasian watermilfoil has reached nuisance conditions. This strategy has been effective at reducing the short-term impact of this species, but Eurasian watermilfoil continues to reinfest treatment areas every season. The current management activity waits for the problem to arise before taking action. A more proactive action plan should be initiated. This would allow control of Eurasian watermilfoil before it develops a large biomass thus reducing the amount of dead and decaying plant material following a treatment. A more aggressive approach may also help increase the establishment of native vegetation in treatment areas.

If Eurasian watermilfoil is dramatically reduced it is likely that pondweed species will cause problems with boat and dock access (this phenomenon was experienced in 2004 following the first triclopyr treatment). These species should be managed only if they are determined by the LLCD to be at nuisance levels. Nuisance aquatic vegetation, as used in this paper, describes plant growth that negatively impacts the present uses of the lake including fishing, boating, swimming, aesthetic, and lakefront property values. However, special consideration should be given native vegetation prior to initiating management activities. Currently the LLCD provides rakes for cutting and removing aquatic vegetation. In minor native infestations, effected parties should be encouraged to use the rakes for control of the native vegetation.

Spatterdock and American Lotus will continue to encroach on boating lanes and beyond maintenance lines in the eastern end of the lake. These maintenance lines should remain in place and the boating lanes should continue to be maintained with herbicide applications. This treatment has been very effective at reducing the impact of these species. Less acreage has required treatment each year for the last three years.

The main thrust of the action plan should be the increased proactive control of Eurasian watermilfoil. As previously discussed, systemic herbicide applications are the most effective tool for control of this species. There are two systemic herbicides which can be used in Lake Lemon for control of this species; fluridone and triclopyr. Both of these herbicides, if applied correctly, are selective towards Eurasian watermilfoil. There are two options which should be considered in order to obtain long-term control of this nuisance exotic species;

1. Whole Lake Fluridone Treatment
2. Triclopyr Treatment

Whole Lake Fluridone Treatment

As previously mentioned, fluridone is the most effective herbicide available for long-term control of Eurasian watermilfoil. A whole-lake fluridone treatment would most likely control Eurasian watermilfoil for 3-6 years in Lake Lemon. This herbicide, applied properly, can selectively control Eurasian watermilfoil with limited harm to most native species. Fluridone treatments will also prevent Eurasian watermilfoil from reaching nuisance levels thus reducing the amount of decaying biomass. Years following a whole lake treatment should be devoted to plant sampling in order to document any increases in native vegetation and to locate any Eurasian watermilfoil plants that may have survived.

If any Eurasian watermilfoil is located it should be treated as soon as possible with triclopyr herbicide in order to prevent and/or slow reinfestation. This will allow a longer period of control before additional fluridone treatments may be needed.

An important step in figuring a proper fluridone dosage is figuring the lake volume. This step has recently been completed by Remetrix in the 2004 report titled "Sediment Depths, Bathymetry, and Volume Assessment of Lake Lemon, Unionville, Indiana". In addition to the volume calculation, a PlanTEST should be completed prior to application. This testing determines the minimum dosage needed to control Eurasian watermilfoil growing in Lake Lemon. After the initial treatment is made, the fluridone concentration should be monitored with the FasTEST. This will allow for any necessary adjustment in the dosage. An EffecTEST can also be completed on Eurasian watermilfoil in order to monitor how the plants are being affected by the treatment. These tools combined with the volumetric calculation will allow an applicator to apply a very accurate fluridone dose that will limit damage to native vegetation and effectively control Eurasian watermilfoil. However, due to the high cost and relatively limited area infested with this exotic species, it is recommended that triclopy be used to treat milfoil in selected areas. If the triclopyr treatment proves unsuccessful, a whole lake fluridone treatment may be the best option for Eurasian watermilfoil control.

Triclopyr Treatments

In 2003 and 2004, triclopyr treatments were completed in several different areas for control of Eurasian watermilfoil. These beds were primarily interfering with dock access. Only Eurasian watermilfoil areas that were considered to be at a nuisance level were treated. Large beds of Eurasian watermilfoil were present throughout the lake but not treated due to a limited budget. It is likely that these plants re-infest the treatment areas. The triclopyr treatments have exhibited much better control of Eurasian watermilfoil than endothal applications. Triclopyr should continue to be used as the primary Eurasian watermilfoil management tool. This herbicide should be applied to all areas where Eurasian watermilfoil occurs in order to prevent surviving plants from quickly reinfesting treatment areas. Up to 125 acres may require treatment in 2005, but this needs to be determined following spring plant sampling. Summer plant sampling should also be completed in order to document the effectiveness of the treatment and the recovery of the native plant population. The number of acres of Eurasian watermilfoil requiring treatment should decline each season (see Table 7 at the end of this section).

Additional Management Options

If either of the above control options is initiated it is likely there will be an increase in native vegetation especially pondweed species (this was experienced in 2004 following limited triclopyr applications). These native species are beneficial for fish cover, nutrient filtering, and the overall health of Lake Lemon, but they may create some nuisance conditions in and around dock areas. Funds should be budgeted to treat these native species if, and only if, they reach nuisance conditions as determined by the LLCD.

Treatment of American lotus and spatterdock should continue. The current maintenance lines and boating lanes should be maintained with herbicide applications. The maintenance currently allows a great deal of rooted floating vegetation to remain in shallow areas, while keeping boating lanes open.

Aquatic vegetation sampling should be a part of any action plan. This sampling should consist of a Tier I survey and a pair of Tier II surveys. These surveys should be completed in late May and July. Such surveys will monitor the effects of herbicide treatments and determine if adjustments need to be made in the management strategy. The data gathered from this sampling will be valuable for planning future management activities.

In addition to the herbicide Eurasian watermilfoil control program, lake draw-down should continue. Eurasian watermilfoil has continued to create nuisance conditions despite drawdowns in the winter, but this is likely due to the difficulty in maintaining lowered levels during the colder months. This difficulty is a result of a relatively larger watershed compared to lake size. Residents should be encouraged to rake the exposed shoreline once the lake has been lowered in order to expose plant material to the winter conditions.

The LLCD currently provides specifically designed aquatic vegetation rakes for manual removal of vegetation. Residents that experience interference from submersed vegetation can legally manage a 625 square foot area. The LLCD should continue to provide these tools, but residents should be reminded of the 625 square foot restriction and the overall benefits of native vegetation.

Table 7. Budget <u>estimate</u> for management options

	2005	**2006**	**2007**	**2008**
Triclopyr Application Cost (Eurasian watermilfoil only)	$50,000	$30,000	$20,000	$10,000
Herbicide & Application Cost (spatterdock, lotus, and pondweeds)	$6,000	$10,000	$12,000	$15,000
Vegetation Sampling & Plan Update	$5,200	$5,200	$5,200	$5,200
Total:	**$61,200**	**$45,200**	**$37,200**	**$30,200**

*Following November meeting, the Lake Lemon Conservancy decided to pursue management option 2.

Education

It is important that all lake users, lake residents, and other stakeholders participate and be informed about the lake management activities. A meeting was conducted November 17, 2004 in order to obtain user input and discuss the updated management plan. Approximately 20 lake users were present at the meeting and their valuable input has been noted in this report. A second meeting should also be scheduled to discuss the final management plan. Each winter a meeting should take place to discuss necessary changes in the plan and to update lake users of changes and activities. The LLCD newsletter should continue to be used to discuss aquatic vegetation management activities, treatment restrictions, and management options. Additional information concerning aquatic vegetation management can be obtained at the following web sites: www.mapms.org www.aquatics.org www.apms.org, www.aquaticcontrol.com and www.nalms.org .

References

Applied Biochemists. 1998. Water weeds and algae, 5th edition. Applied Biochemists, J. C. Schmidt and J. R. Kannenberg, editors. Milwaukee, Wisconsin.

Aquatic Control Inc. 2001. Fish Management Report, Lake Lemon 2000. Prepared for Lake Lemon Conservancy District. Aquatic Control Inc. P.O. Box 100 Seymour, Indiana.

Bachman, R.W., Horsburgh, C.A., Hoyer, M.V., Mataraza, L.K., and D.E. Canfield. 2002. Relations between trophic state indicators and plant biomass in Florida Lakes. Department of Fisheries and Aquatic Sciences, University of Florida. Hydrobiologia 470:219-234.

Bright Spot Maps. 1996. Kosciusko-Marshall-Fulton-Elkhart-St. Joseph Counties, 74 Lake Maps Featuring Contours and Depths. Laporte, IN

Chadde, S.W. 1998. A Great Lakes Wetland Flora. Pockteflora Press, Calumet Michigan.

DiTomaso, J. M. and E.A. Healy. 2003. Aquatic and Riparian Weeds of the West. University of California Agriculture and Natural Resources. Oakland, CA.

Fassett, N.C. 1968. A Manual of Aquatic Plants. The University of Wisconsin Press. Madison, WI.

Getsinger, K.D., Turner, E.G., Madsen, J.D., and M.D. Netherland. 1997. Restoring Native Vegetation in a Eurasian Water Milfoil-Dominated Plant Community Using The Herbicide Triclopyr. Regulated Rivers: Research & Management, Vol. 13, 357-375

Hoffman, J., 2000, Lake Lemon Conservancy District Aquatic Plant Management Plan. 2000. Lake Lemon Conservancy District.

IDNR. 2004. Procedure Manual For Surveying Aquatic Vegetation: Tier I Reconnaissance Surveys. IN Department of Natural Resources, Division of Soil Conservation.

IDNR. 2004. Procedure Manual For Surveying Aquatic Vegetation: Tier II Reconnaissance Surveys. IN Department of Natural Resources, Division of Soil Conservation.

Jones, W. 1986. A Diagnostic and Feasibility Study of Lake Lemon. Bloomington, Indiana.

Maceina, M.J., Reeves, W.C., Wrenn, W.B., and D.R. Lowery. 1996. Relationships between Largemouth Bass and Aquatic Plants in Guntersville Reservoir, Alabama. American Fisheries Socieyt Symposium 16:382-395.

Madsen, J.D., Sutherland, J.W., Bloomfield, J.A., Eichler, L.W., and C.W. Boylen. 1998. The decline of native vegetation under dense Eurasian watermilfoil canopies. Journal of Aquatic Plant Management., 29, 94-99.

Malcom Pirnie, Inc., 2002. Lake Lemon Watershed Management Plan. Prepared for Lake Lemon Conservancy District. White Plains, NY.

North American Lake Management Society and the Aquatic Plant Management Society. 1997. Aquatic Plant Management in Lakes and Reservoirs. U.S. Environmental Protection Agency Office of Water Assessment and Watershed Protection Division, Washington, DC.

Pearson, J. 2004. A proposed sampling method to assess occurrence, abundance and distribution of submersed aquatic plants in Indiana lakes. IN Department of Natural Resources. Division of Fish & Wildlife.

Scribalio, R.W., and M.S. Alix. 2003. Final Report on the Weevil Release Study for Indiana Lakes. Department of Botany and Plant Pathology. Purdue University. West Lafayette, IN.

Skogerboe, J.G., and K.D. Getsinger. 2002. Endothall species selectivity evaluation: northern latitude aquatic plant community. J. Aquatic Plant Management. 40: 1-5.

Smith, C.S. 2002. Houghton Lake Management Feasibility Study. Prepared for the Houghton Lake Improvement Board. Remetrix LLC. Indianapolis, IN.

Winterringer, G.S., and A.C. Lopinot. 1977. Aquatic Plants of Illinois. Department of Registration & Education, Illinois State Museum Division & Department of Conservation, Division of Fisheries. Springfield, IL.

Appendix A. Macrophyte List for Lake Lemon

Common Name	**Scientific Name**	**Tier I '04**	**Tier II '04**	**LLCD List**
American elodea	*Elodea canadensis*	X	X	X
American lotus	*Nelumbo lutea*	X	X	X
American pondweed	*Potamogeton nodosus*	X	X	X
American water willow	*Justica americana*	X		X
Arrowhead sp.	*Sagitaria spp.*			X
Brittle naiad	*Najas minor*	X	X	
Bulrush	*Scirpus spp.*			X
Chara	*Chara spp.*	X	X	X
Common cattail	*Typhia latifolia*			X
Common coontail	*Ceratophyllum demersum*	X	X	X
Curlyleaf pondweed	*Potamogeton crispus*	X	X	X
Eurasian watermilfoil	*Myriophyllum spicatum*	X	X	X
Floating-leaf pondweed	*Potamogeton natans*			X
Horned pondweed	*Zannichellia palustris*		X	X
Lesser duckweed	*Lemna minor*			X
Native milfoil Sp	*Myriophyllum spp.*			X
Purple loosestrife	*Lythrum salicaria*			X
Sago pondweed	*Potomogeton pectinatus*	X		X
Slender naiad	*Najas flexilis*			X
Small pondweed	*Potamogeton pusillus*	X	X	
Watermeal	*Wolfia spp.*	X		
Spatterdock	*Nuphar spp.*	X		X

American lotus *(Nelumbo lutea)* is an emergent dicot with a large circular leaf which often reaches several feet above the waters surface. Provides shade and shelter for fish. Young seeds are often eaten by waterfowl. Rootstocks are eaten by muskrats and beaver.

American pondweed (*Potomogeton nodosus*) is a perennial herb that often times is referred to as longleaf pondweed. Contains submersed and floating leaves. Occupies shallow water. Occurs throughout North America. Reproduces through rhizomes and seeds.

American water willow (*Justica americana*)is a perennial herb, spreading by rhizomes and sometimes forming large colonies. Stems are usually unbranched and smooth. Leaves are opposite, linear to lance-shaped, and tapered to a tip. Inhabits shallow water, muddy pond and lakeshores, and mud bars[2]. Considered good fish cover, especially for largemouth bass.

Chara (*chara spp.)* is an anchored green algae with whorled, branchlike filaments at the nodes of a central axis. Often times mistaken for vascular plants. Typically inhabits shallow water. Provide food and cover for wildlife. Rarely reaches the surface of the water and rarely causes problem.

Common coontail (*Ceratophylum demersum*) is a commonly occurring aquatic plant in the Midwest in neutral to alkaline waters[1]. It is a submersed dicot with coarsely toothed leaves whorled about the stem[2]. This plant is given its name due to its resemblance to the tail of a raccoon. Coontail has been found to be an important food source for wildfowl as well as a good shelter for small animals[2]. This plant is also a good shelter for young fish, and support of insects[2], but has been known to crowd out other species of aquatic plants[3].

Curlyleaf pondweed (*Potamogeton crispus*) is a submersed monocot with slightly clasping, rounded tip leaves. The flowers occur on dense cylindrical spikes and produces distinctive beaked fruit[1]. Curly leaf is eaten by ducks, but may become a weed[2]. This plant provides good food, shelter, and shade for fish and is important for early spawning fish like carp and goldfish[2].

Eurasian watermilfoil (*Myriophyllum spicatum*) is an exotic aquatic plant that has been known to crowd out native species of plants. This species spreads quickly because it can grow from very small plant fragments and survive in low light and nutrient conditions[3]. This dicot has stems that typically grow to the water surface and branch out forming a canopy that shades other species of aquatic plants. Eurasian water-milfoil has characteristic red to pink flowering spikes that protrude from the water surface one to two inches high[1]. The segmented leaves grow in whorls of three to four around the stem[1]. grow from very small plant fragments and survive in low light and nutrient conditions[4]. This dicot has stems that typically grow to the water surface and branch out forming a canopy that shades other species of aquatic plants. Eurasian water-

[1] Chadde, S. 1998. Great lakes wetland flora. Pocketflora Press, Calumet, Michigan.

[2] Fassett, N. 1957. A manual of aquatic plants, 2nd edition. The University of Wisconsin Press, Madison, Wisconsin.

[3]Applied Biocehmists, 1998. Water weeds and algae, 5th edition. Applied Biochemists, J. C. Schmidt and J. R. Kannenberg, editors. Milwaukee, Wisconsin.

milfoil has characteristic red to pink flowering spikes that protrude from the water surface one to two inches high[1]. The segmented leaves grow in whorls of three to four around the stem[1]. This exotic plant is easily differentiated from its native relative, northern milfoil, by stem growth and the numbers of sections per leaf.

Horned pondweed (*Zannichellia palustris*) is a common perennial aquatic herb with creeping rhizome and often forming extensive underwater mats. Flowers are small, produced underwater, either male or female, and separate on plant but from the same leaf axil. Plant usually common in spring and senesces in summer.

Small pondweed (*Potamogeton pusillus*) is a submersed monocot with slender, long leaves. Its fruit is green to brown and has a flat beak[1]. This plant provides fish with good cover and food and is a good food source for wildfowl[2]. This species has a propensity for developing nuisance conditions when competition from other species is not present.

Sago pondweed (*Potamogeton pectinata*) is a submersed monocot with leaves that are threadlike to narrowly linear that form a sheath around the stem[1]. The nutlet and tubers of this plant make it the most important pondweed for ducks[2]. It also provides food and shelter for young trout and other fish[2]. This species can produce thick nuisance growth in shallow near-shore areas of lakes.

Spatterdock (*Nuphar spp.*) is an emergent dicot with broad, deeply lobed leaves emerging from the water[1]. This plant has distinctive large yellow flowers emanating from spikes. Spatterdock produces seeds and rootstocks that are used by wildfowl, beaver, moose and porcupine[2]. This plant attracts wildfowl and marsh birds and the bases of the petioles are eaten by muskrats[2]. Spatterdock is a poor producer of food for fish, but provide good shade and shelter[2].

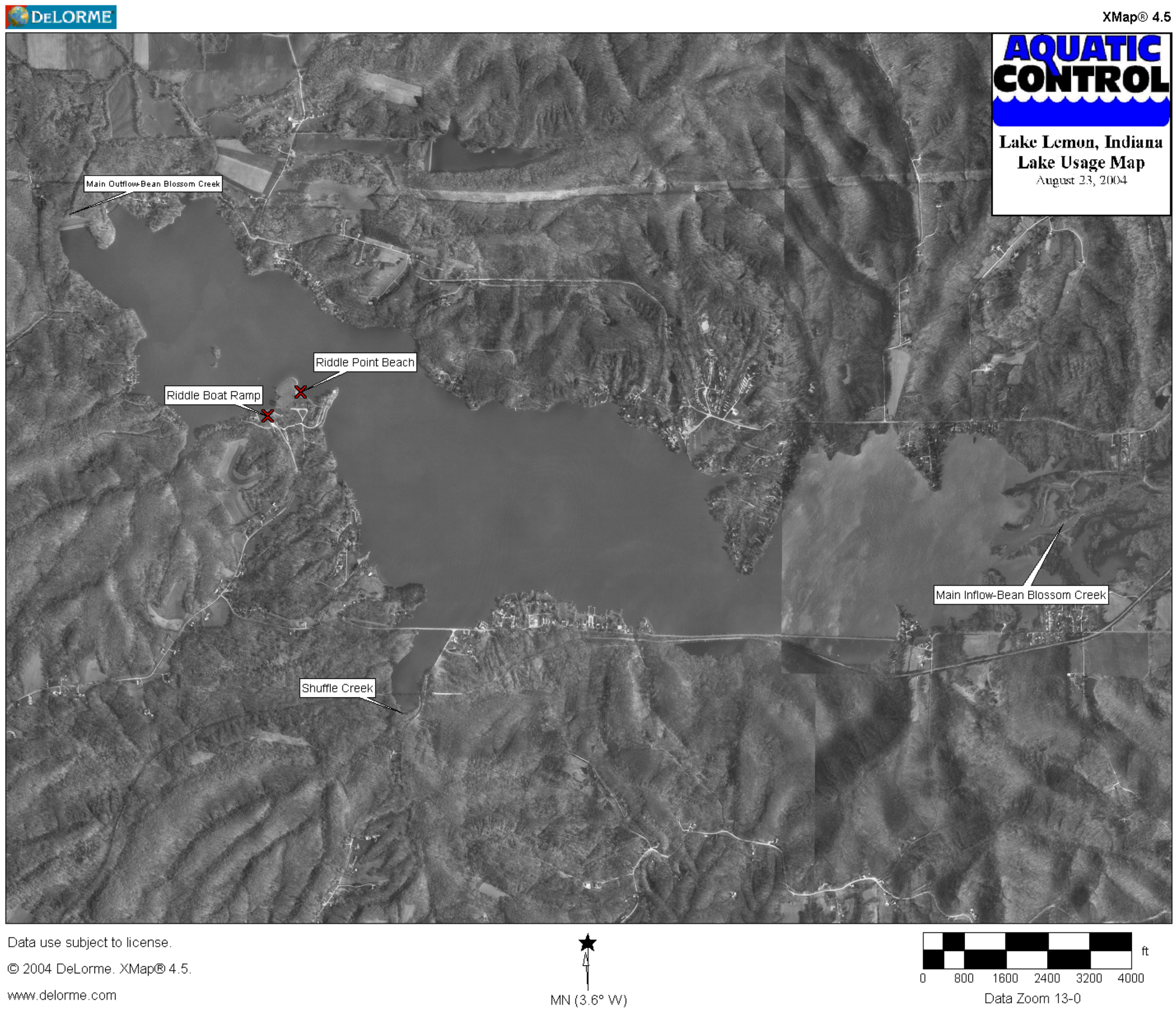
---

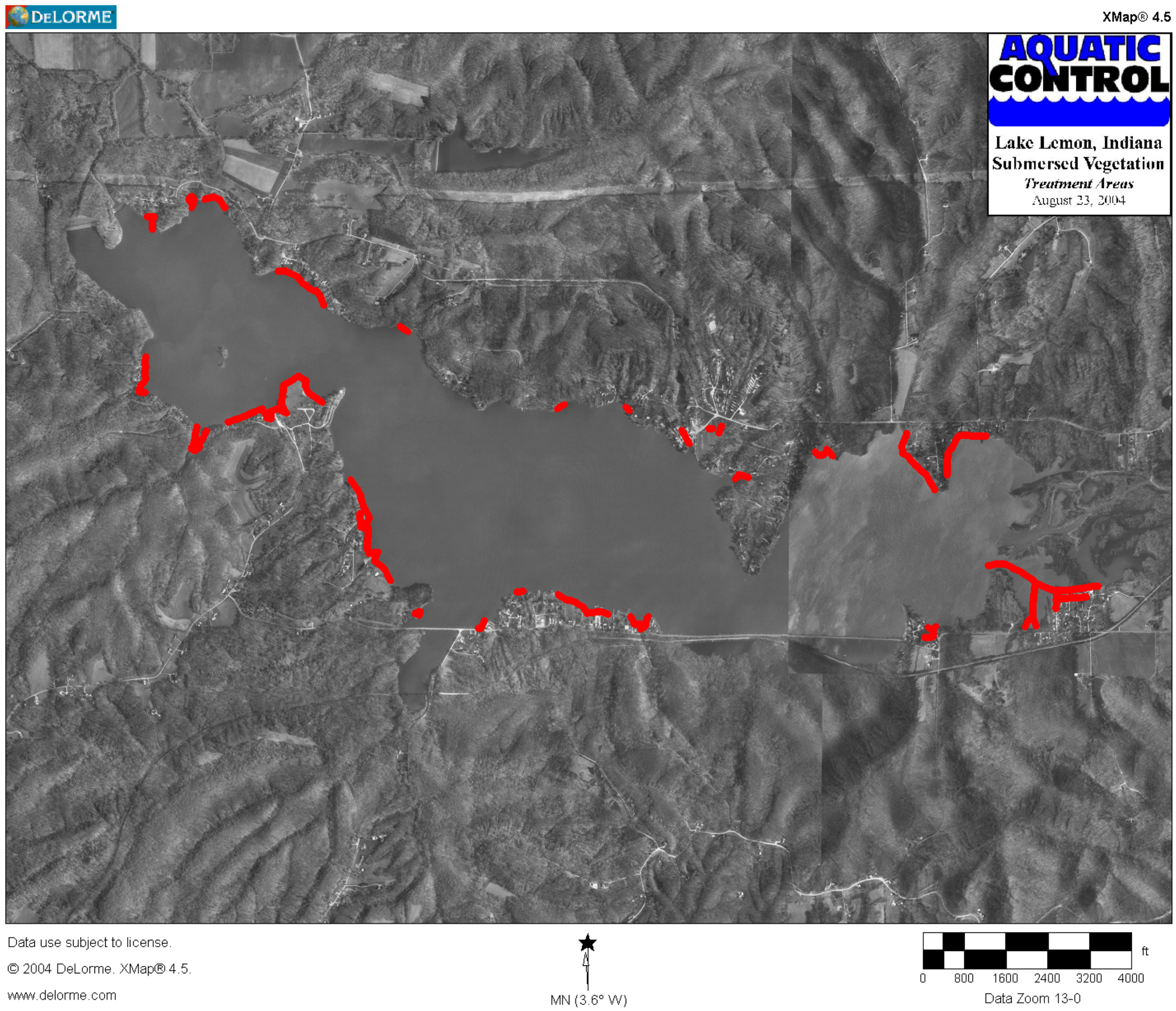
[1] Chadde, S. 1998. Great lakes wetland flora. Pocketflora Press, Calumet, Michigan.

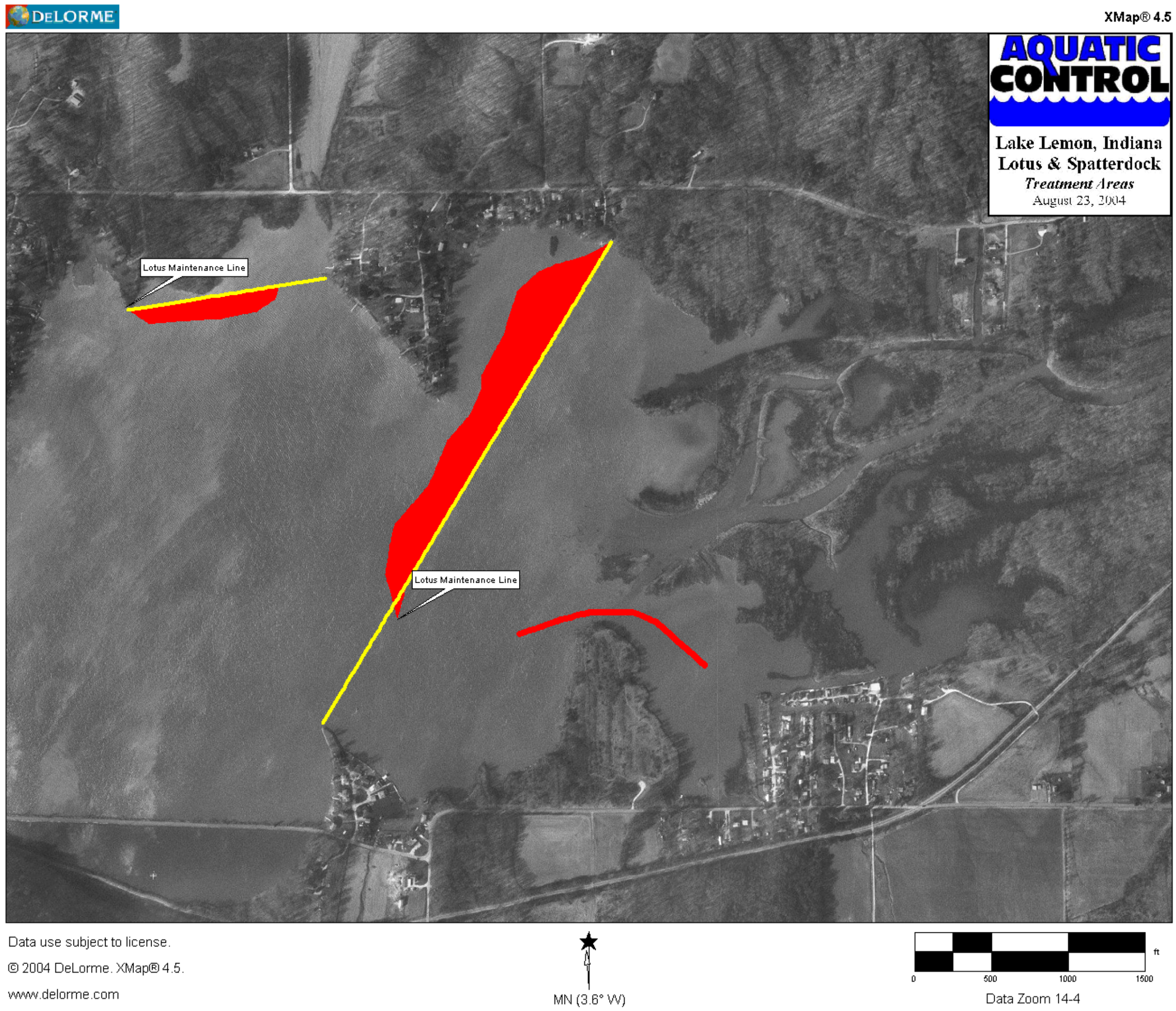
[2] Fassett, N. 1957. A manual of aquatic plants, 2nd edition. The University of Wisconsin Press, Madison, Wisconsin.

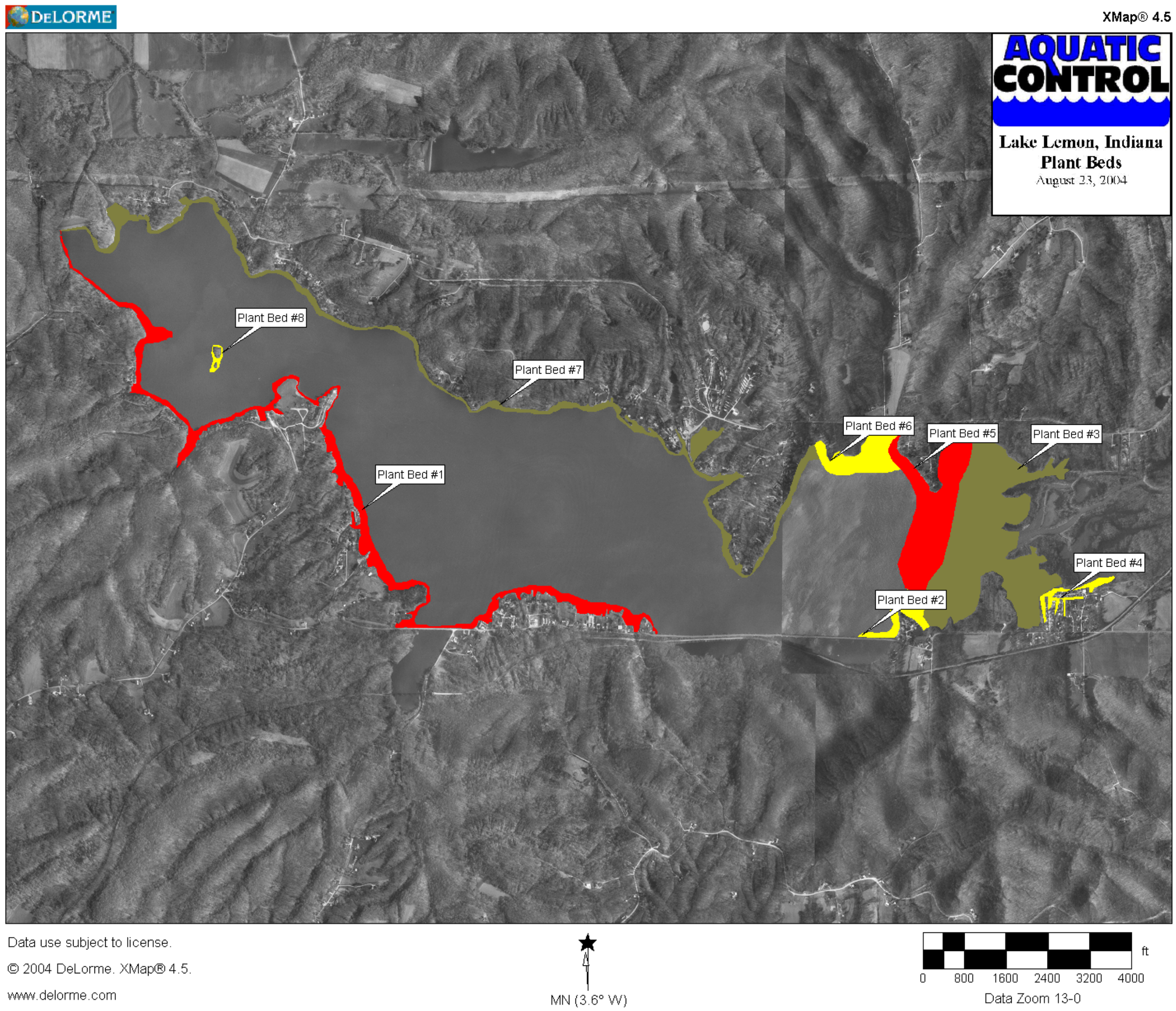
[3]Applied Biocehmists, 1998. Water weeds and algae, 5th edition. Applied Biochemists, J. C. Schmidt and J. R. Kannenberg, editors. Milwaukee, Wisconsin.

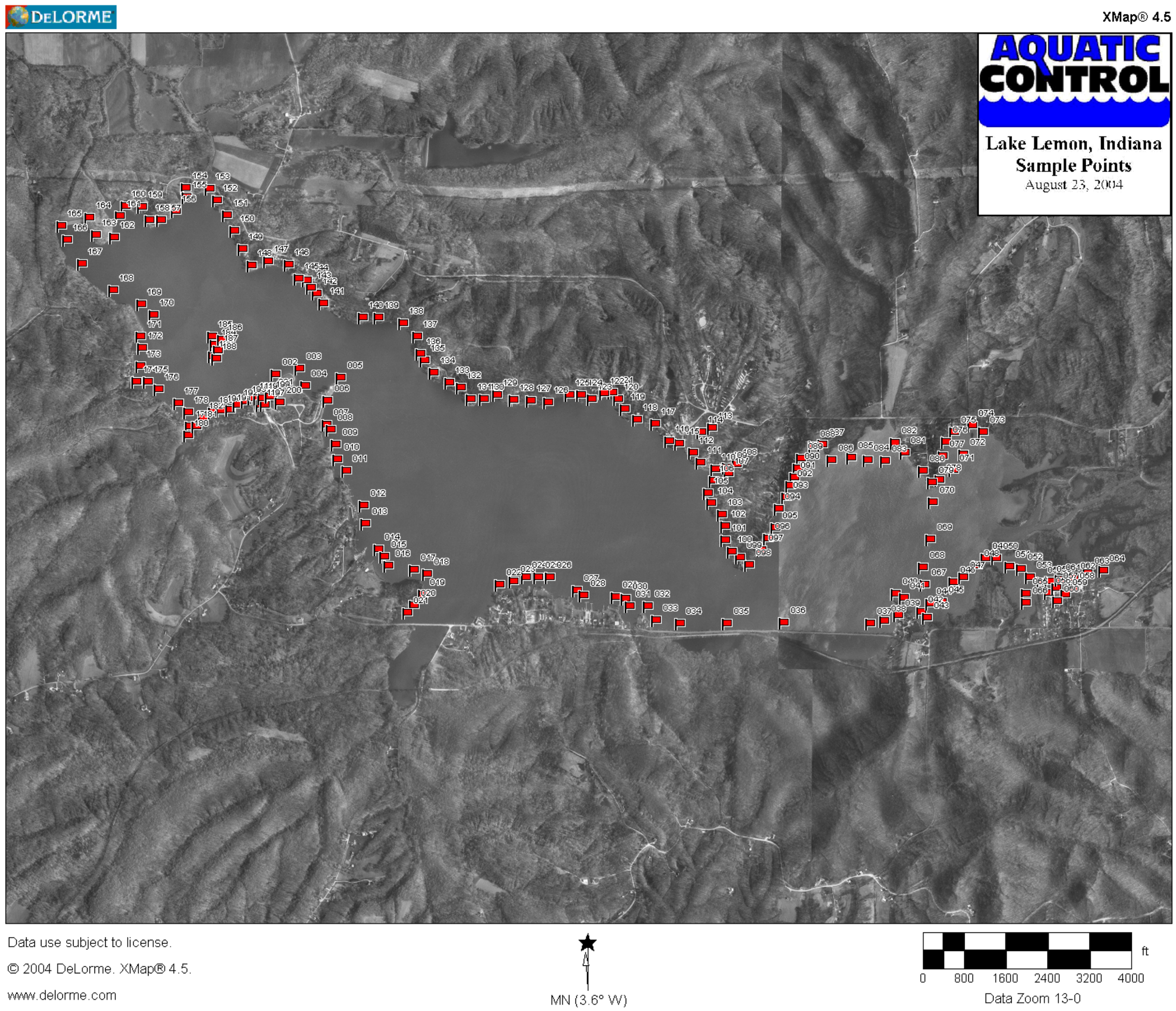
Appendix B. Maps

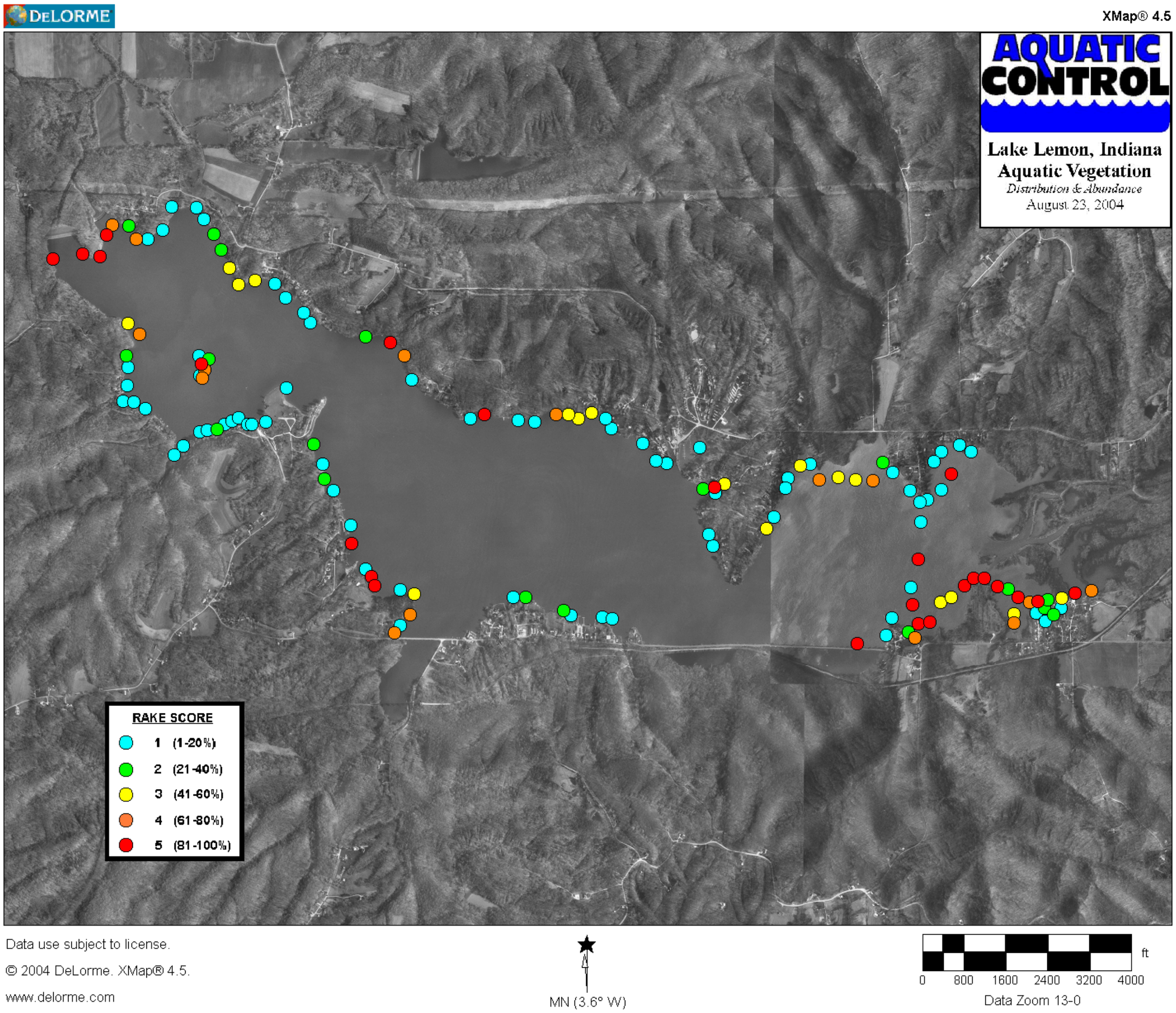


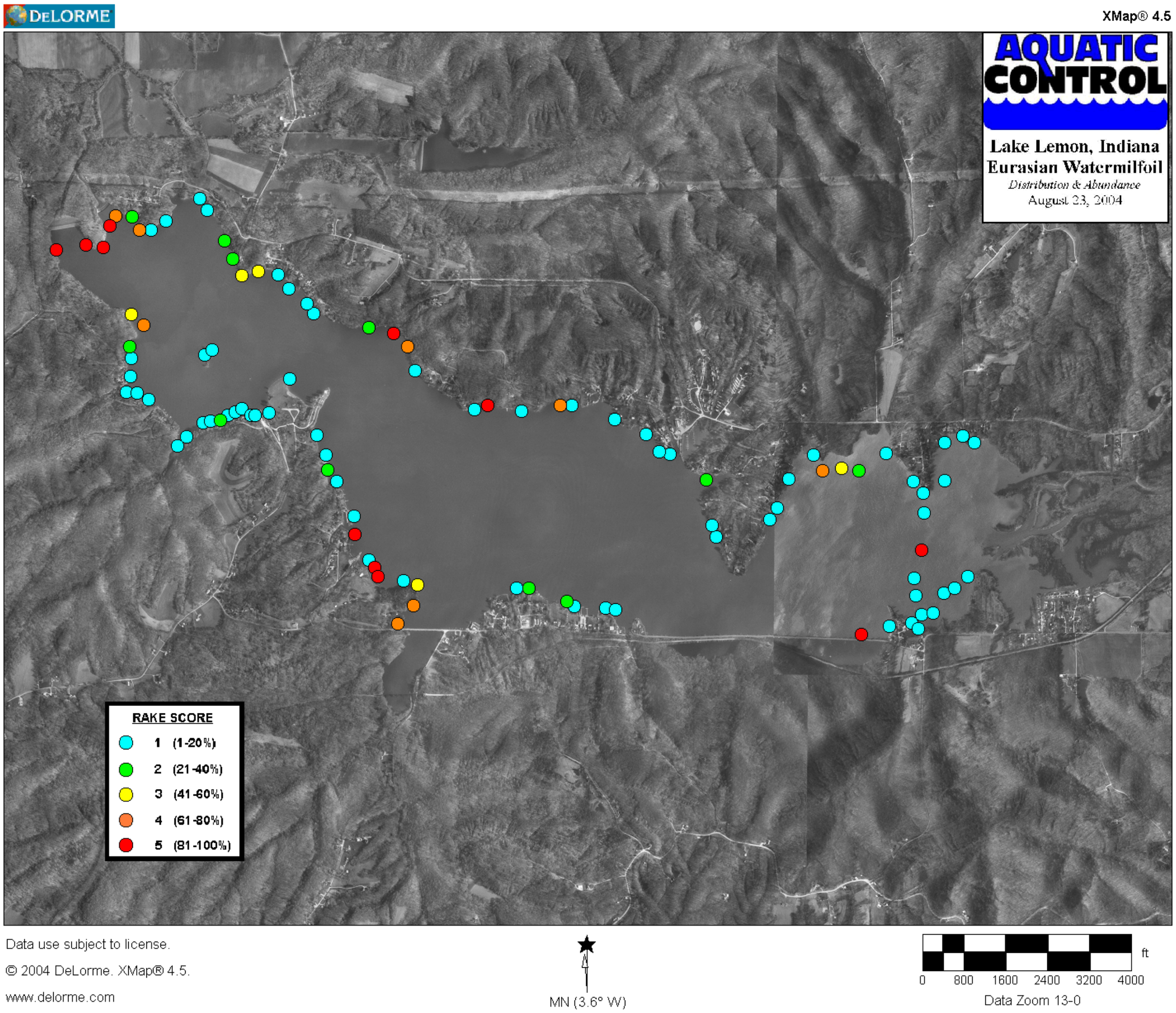

DELORME
XMap® 4.5
AQUATIC CONTROL
Lake Lemon, Indiana
Submersed Vegetation
Treatment Areas
August 23, 2004
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
MN (3.6° W)
0 800 1600 2400 3200 4000 ft
Data Zoom 13-0

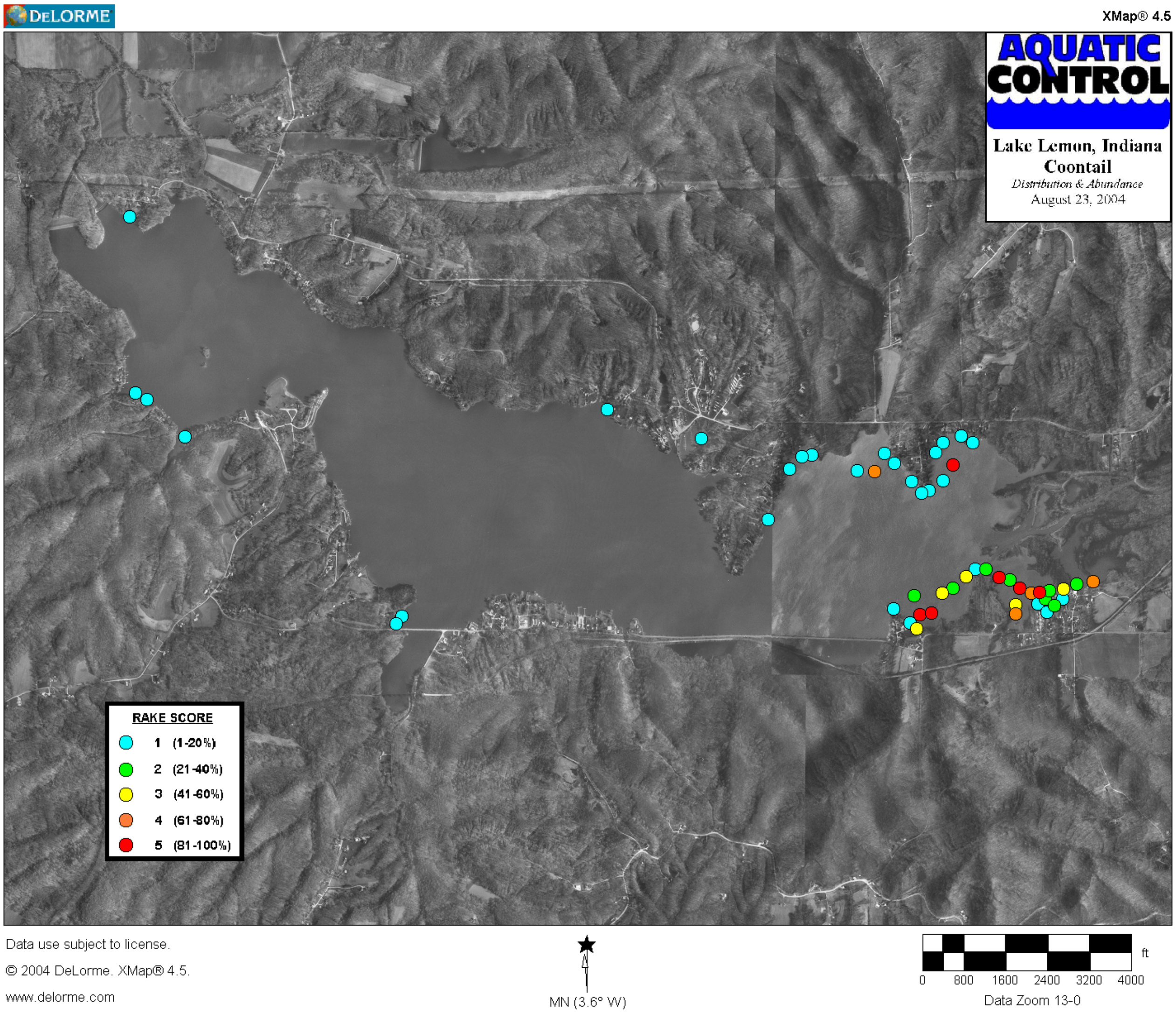

DeLorme
XMap® 4.5
AQUATIC CONTROL
Lake Lemon, Indiana
Lotus & Spatterdock
Treatment Areas
August 23, 2004
Lotus Maintenance Line
Lotus Maintenance Line
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
MN (3.6° W)
0
500
1000
1500
ft
Data Zoom 14-4

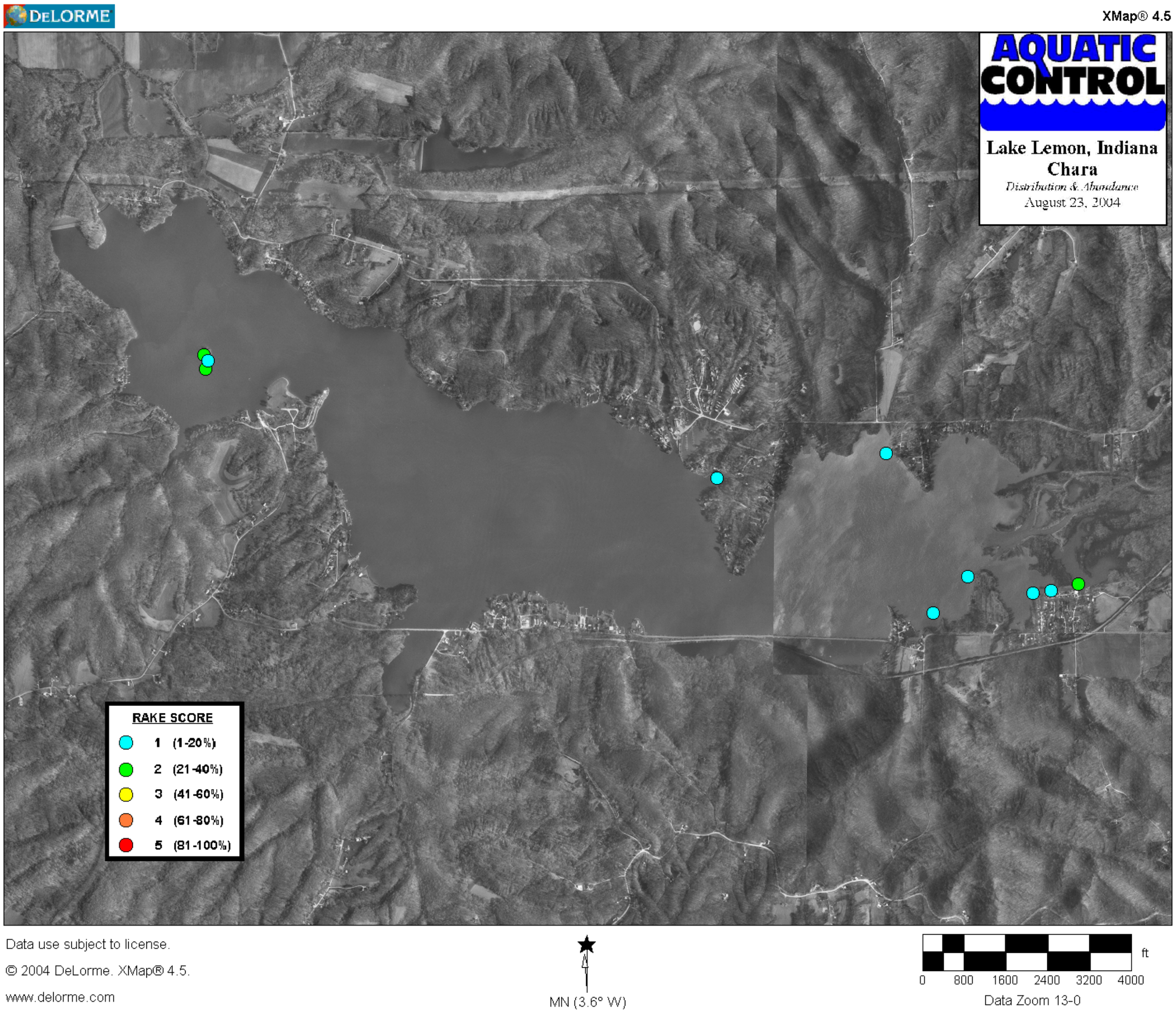

DeLORME
XMap® 4.5
AQUATIC CONTROL
Lake Lemon, Indiana
Plant Beds
August 23, 2004
Plant Bed #8
Plant Bed #7
Plant Bed #1
Plant Bed #6
Plant Bed #5
Plant Bed #3
Plant Bed #4
Plant Bed #2
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
MN (3.6° W)
0 800 1600 2400 3200 4000
ft
Data Zoom 13-0

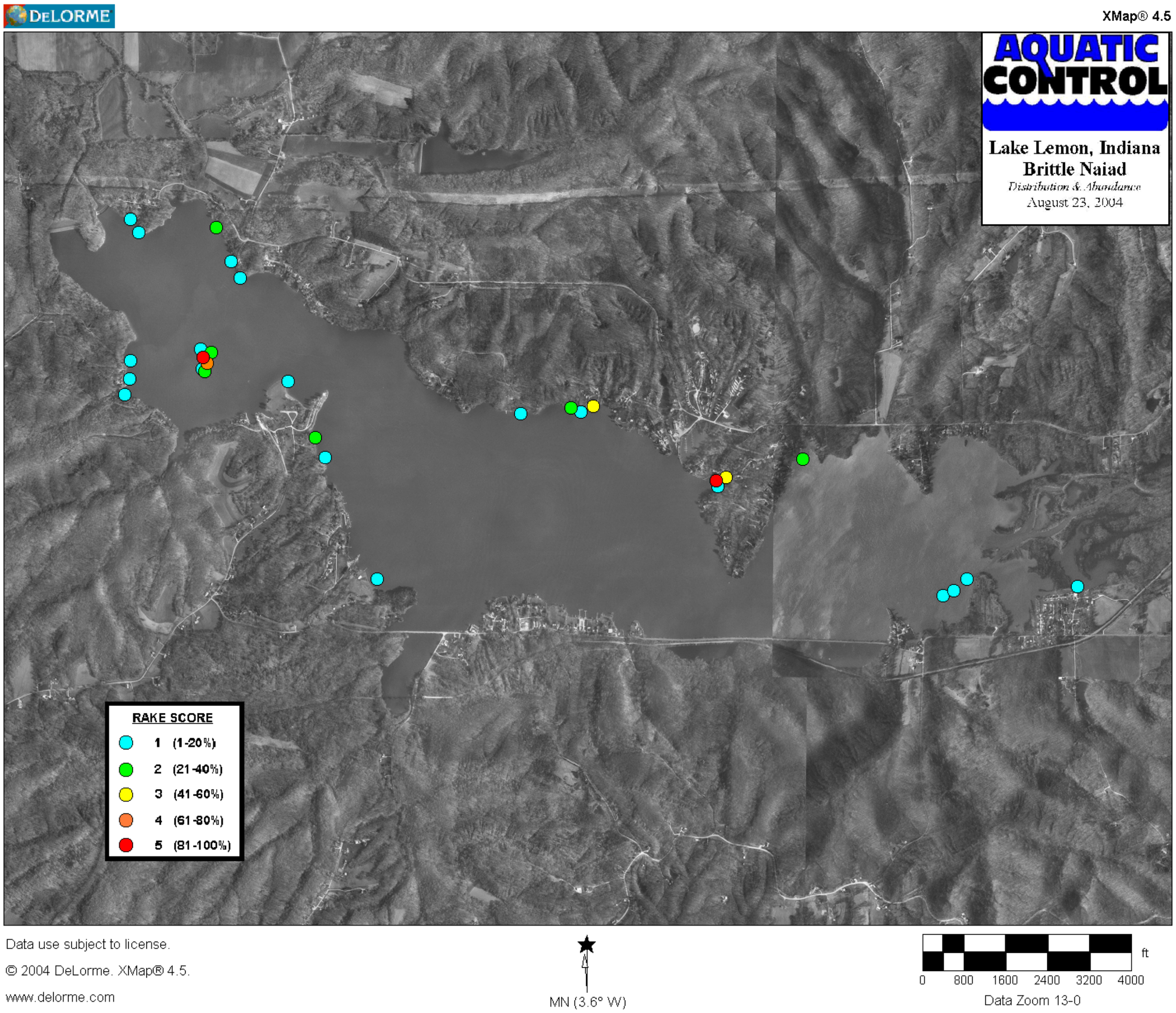

DeLORME
XMap® 4.5
AQUATIC CONTROL
Lake Lemon, Indiana
Sample Points
August 23, 2004
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
MN (3.6° W)
ft
0 800 1600 2400 3200 4000
Data Zoom 13-0

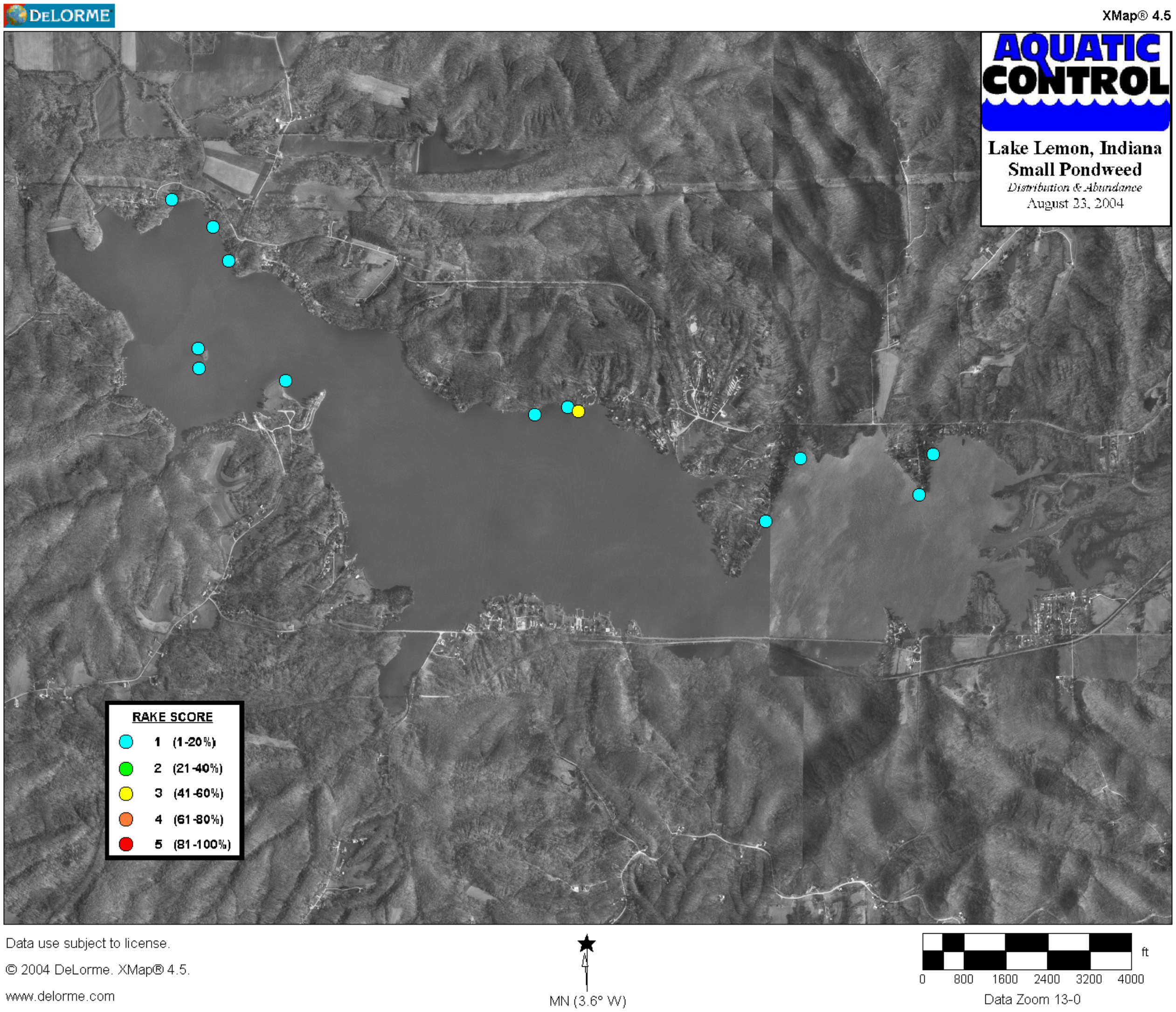

DELORME
XMap® 4.5
AQUATIC CONTROL
Lake Lemon, Indiana
Aquatic Vegetation
Distribution & Abundance
August 23, 2004
RAKE SCORE
1 (1-20%)
2 (21-40%)
3 (41-60%)
4 (61-80%)
5 (81-100%)
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
MN (3.6° W)
ft
0 800 1600 2400 3200 4000
Data Zoom 13-0


DELORME
XMap® 4.5
AQUATIC CONTROL
Lake Lemon, Indiana
Eurasian Watermilfoil
Distribution & Abundance
August 23, 2004
RAKE SCORE
1 (1-20%)
2 (21-40%)
3 (41-60%)
4 (61-80%)
5 (81-100%)
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
MN (3.6° W)
0 800 1600 2400 3200 4000
ft
Data Zoom 13-0


DELORME
XMap® 4.5
AQUATIC CONTROL
Lake Lemon, Indiana
Coontail
Distribution & Abundance
August 23, 2004
RAKE SCORE
1 (1-20%)
2 (21-40%)
3 (41-60%)
4 (61-80%)
5 (81-100%)
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
MN (3.6° W)
ft
0 800 1600 2400 3200 4000
Data Zoom 13-0


DELORME
XMap® 4.5
AQUATIC CONTROL
Lake Lemon, Indiana
Chara
Distribution & Abundance
August 23, 2004
RAKE SCORE
1 (1-20%)
2 (21-40%)
3 (41-60%)
4 (61-80%)
5 (81-100%)
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
MN (3.6° W)
0 800 1600 2400 3200 4000 ft
Data Zoom 13-0


DeLorme
XMap® 4.5
AQUATIC CONTROL
Lake Lemon, Indiana
Brittle Naiad
Distribution & Abundance
August 23, 2004
RAKE SCORE
1 (1-20%)
2 (21-40%)
3 (41-60%)
4 (61-80%)
5 (81-100%)
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
MN (3.6° W)
0 800 1600 2400 3200 4000 ft
Data Zoom 13-0


DeLorme
XMap® 4.5
AQUATIC CONTROL
Lake Lemon, Indiana
Small Pondweed
Distribution & Abundance
August 23, 2004
RAKE SCORE
1 (1-20%)
2 (21-40%)
3 (41-60%)
4 (61-80%)
5 (81-100%)
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
MN (3.6° W)
ft
0 800 1600 2400 3200 4000
Data Zoom 13-0

Appendix C. Tier II Data Sheets.

Lake	Date	Latitude	Longitude	Site	Depth	RAKE	MYSP2	POCR3	CEDE4	CH?AR	NAMI	POPU7	ELCA7	PONO2	ZAPA	NELU	ALGA	SpeNum	NatSpeNum
Lemon	8/23/04	39.26312	-86.41324	1	4.0	0												0	0
Lemon	8/23/04	39.26415	-86.41305	2	2.0	0												0	0
Lemon	8/23/04	39.26444	-86.41143	3	2.0	1	1				1	1						3	2
Lemon	8/23/04	39.26356	-86.41106	4	6.0	0												0	0
Lemon	8/23/04	39.26399	-86.40866	5	4.0	0												0	0
Lemon	8/23/04	39.26275	-86.40951	6	3.0	0												0	0
Lemon	8/23/04	39.26152	-86.40959	7	1.0	2	1				2							2	1
Lemon	8/23/04	39.26124	-86.40930	8	4.0	0												0	0
Lemon	8/23/04	39.26049	-86.40896	9	3.0	1	1				1							2	1
Lemon	8/23/04	39.25971	-86.40885	10	3.0	2	2											1	0
Lemon	8/23/04	39.25912	-86.40823	11	2.0	1	1											1	0
Lemon	8/23/04	39.25727	-86.40707	12	3.0	1	1											1	0
Lemon	8/23/04	39.25635	-86.40699	13	4.0	5	5											1	0
Lemon	8/23/04	39.25500	-86.40607	14	3.0	1	1											1	0
Lemon	8/23/04	39.25460	-86.40568	15	3.0	5	5											1	0
Lemon	8/23/04	39.25413	-86.40544	16	3.0	5	5				1							2	1
Lemon	8/23/04	39.25392	-86.40370	17	6.0	1	1											1	0
Lemon	8/23/04	39.25369	-86.40280	18	5.0	3	3											1	0
Lemon	8/23/04	39.25264	-86.40308	19	4.0	4	4											1	0
Lemon	8/23/04	39.25208	-86.40371	20	4.0	1			1									1	1
Lemon	8/23/04	39.25169	-86.40411	21	3.0	4	4		1									2	1
Lemon	8/23/04	39.25313	-86.39789	22	4.0	0												0	0
Lemon	8/23/04	39.25333	-86.39694	23	3.0	0												0	0
Lemon	8/23/04	39.25355	-86.39611	24	6.0	1	1											1	0
Lemon	8/23/04	39.25355	-86.39526	25	5.0	2	2											1	0
Lemon	8/23/04	39.25355	-86.39449	26	6.0	0												0	0
Lemon	8/23/04	39.25284	-86.39269	27	3.0	2	2											1	0
Lemon	8/23/04	39.25257	-86.39222	28	4.0	1	1											1	0
Lemon	8/23/04	39.25252	-86.39007	29	4.0	1	1											1	0
Lemon	8/23/04	39.25241	-86.38941	30	3.0	1	1											1	0
Lemon	8/23/04	39.25201	-86.38911	31	5.0	0												0	0
Lemon	8/23/04	39.25204	-86.38787	32	5.0	0												0	0
Lemon	8/23/04	39.25128	-86.38731	33	7.0	0												0	0
Lemon	8/23/04	39.25113	-86.38569	34	5.0	0												0	0
Lemon	8/23/04	39.25113	-86.38255	35	7.0	0												0	0
Lemon	8/23/04	39.25117	-86.37868	36	6.0	0												0	0
Lemon	8/23/04	39.25114	-86.37287	37	5.0	5	5											1	0
Lemon	8/23/04	39.25123	-86.37192	38	7.0	0												0	0
Lemon	8/23/04	39.25156	-86.37096	39	3.0	1	1											1	0
Lemon	8/23/04	39.25267	-86.37115	40	4.0	0												0	0
Lemon	8/23/04	39.25245	-86.37057	41	4.0	1			1									1	1
Lemon	8/23/04	39.25171	-86.36942	42	3.0	2	1		1									2	1
Lemon	8/23/04	39.25141	-86.36900	43	1.0	4	1		3									2	1
Lemon	8/23/04	39.25217	-86.36879	44	2.0	5	1		5									2	1
Lemon	8/23/04	39.25225	-86.36801	45	2.0	5	1	1	5	1								4	2
Lemon	8/23/04	39.25330	-86.36726	46	1.0	3	1		3		1		1			1		5	4
Lemon	8/23/04	39.25355	-86.36655	47	2.0	3	1		2		1		1					4	3
Lemon	8/23/04	39.25416	-86.36565	48	2.0	5	1		3	1	1		2					5	4
Lemon	8/23/04	39.25451	-86.36504	49	2.0	5			1				3	2				3	3
Lemon	8/23/04	39.25453	-86.36433	50	1.0	5			2				3	1				3	3
Lemon	8/23/04	39.25409	-86.36344	51	3.0	5			5				3					2	2
Lemon	8/23/04	39.25397	-86.36269	52	3.0	2			2									1	1
Lemon	8/23/04	39.25354	-86.36204	53	3.0	5			5									1	1
Lemon	8/23/04	39.25327	-86.36127	54	3.0	4			4	1								2	2
Lemon	8/23/04	39.25334	-86.36072	55	3.0	5			5									1	1
Lemon	8/23/04	39.25271	-86.36080	56	3.0	1			1									1	1
Lemon	8/23/04	39.25298	-86.36029	57	2.0	2			2									1	1
Lemon	8/23/04	39.25296	-86.35916	58	2.0	1			1									1	1
Lemon	8/23/04	39.25265	-86.35967	59	1.0	2			2									1	1
Lemon	8/23/04	39.25228	-86.36020	60	2.0	1			1									1	1
Lemon	8/23/04	39.25339	-86.36005	61	3.0	2			2	1								2	2
Lemon	8/23/04	39.25348	-86.35909	62	3.0	3			3									1	1
Lemon	8/23/04	39.25375	-86.35818	63	3.0	5			2	2	1							3	3
Lemon	8/23/04	39.25388	-86.35708	64	2.0	4			4									1	1
Lemon	8/23/04	39.25267	-86.36232	65	3.0	3			3									1	1
Lemon	8/23/04	39.25222	-86.36233	66	3.0	4			4									1	1
Lemon	8/23/04	39.25315	-86.36916	67	3.0	5	1	2	2									3	1
Lemon	8/23/04	39.25408	-86.36928	68	3.0	1	1											1	0

Species Codes	
BIBE	Bur marigold
CEDE4	Coontail
CH?AR	Chara
ELCA7	Elodea
LEMN	Duckweeds
MYHE	Broadleaf watermilfoil
MYSI	Northern watermilfoil
MYSP2	Eurasian watermilfoil
MYVE	Whorled watermilfoil
NAFL	Slender naiad
NAGU	Southern waternymph
NAMA	Spiny naiad
NAMI	Brittle waternymph
NELU	American lotus
NI?TE	Nitella
NOAQVG	No aquatic vegetation
NULU	Yellow pond lily
NYTU	White water lily
POAM	Large-leaf pondweed
POCR3	Curly-leaf pondweed
POFO3	Leafy pondweed
POGR8	Variable pondweed
POIL	Illinois pondweed
PONO2	American pondweed
POPE6	Sago pondweed
POPR5	White-stemmed pondweed
POPU7	Small pondweed
PORI2	Richardson's pondweed
POZO	Flat-stemmed pondweed
UTMA	Common bladderwort
VAAM3	Wild celery, eel grass
WO?LF	Watermeal
ZAPA	Horned pondweed
ZODU	Water stargrass

Lake	Date	Latitude	Longitude	Site	Depth	RAKE	MYSP2	POCR3	CEDE4	CH?AR	NAMI	POPU7	ELCA7	PONO2	ZAPA	NELU	ALGA	SpeNum	NatSpeNum
Lemon	8/23/04	39.25554	-86.36878	69	3.0	5	5											1	0
Lemon	8/23/04	39.25746	-86.36861	70	3.0	1	1											1	0
Lemon	8/23/04	39.25914	-86.36723	71	3.0	1	1		1									2	1
Lemon	8/23/04	39.25997	-86.36656	72	2.0	5			5									1	1
Lemon	8/23/04	39.26112	-86.36522	73	2.0	1	1		1									2	1
Lemon	8/23/04	39.26149	-86.36598	74	2.0	1	1		1									2	1
Lemon	8/23/04	39.26113	-86.36720	75	3.0	1	1		1									2	1
Lemon	8/23/04	39.26059	-86.36773	76	3.0	1			1			1						2	2
Lemon	8/23/04	39.25986	-86.36795	77	3.0	0												0	0
Lemon	8/23/04	39.25862	-86.36817	78	2.0	1			1									1	1
Lemon	8/23/04	39.25849	-86.36867	79	3.0	1	1		1			1						3	2
Lemon	8/23/04	39.25910	-86.36931	80	3.0	1	1		1									2	1
Lemon	8/23/04	39.26006	-86.37049	81	2.0	1			1									1	1
Lemon	8/23/04	39.26058	-86.37116	82	1.0	2	1		1	1			1				1	4	3
Lemon	8/23/04	39.25963	-86.37185	83	3.0	4		1	4									2	1
Lemon	8/23/04	39.25965	-86.37302	84	4.0	3	2		1									2	1
Lemon	8/23/04	39.25977	-86.37416	85	4.0	3	3											1	0
Lemon	8/23/04	39.25967	-86.37548	86	3.0	4	4											1	0
Lemon	8/23/04	39.26049	-86.37606	87	2.0	1	1		1									2	1
Lemon	8/23/04	39.26041	-86.37671	88	3.0	3			1		2	1						3	3
Lemon	8/23/04	39.25976	-86.37754	89	4.0	1			1									1	1
Lemon	8/23/04	39.25924	-86.37774	90	5.0	1	1											1	0
Lemon	8/23/04	39.25874	-86.37798	91	6.0	0												0	0
Lemon	8/23/04	39.25832	-86.37824	92	6.0	0												0	0
Lemon	8/23/04	39.25772	-86.37852	93	5.0	1	1											1	0
Lemon	8/23/04	39.25712	-86.37903	94	3.0	3	1		1			1		1				4	3
Lemon	8/23/04	39.25614	-86.37928	95	4.0	0												0	0
Lemon	8/23/04	39.25556	-86.37975	96	6.0	0												0	0
Lemon	8/23/04	39.25495	-86.38021	97	5.0	0												0	0
Lemon	8/23/04	39.25420	-86.38103	98	4.0	0												0	0
Lemon	8/23/04	39.25456	-86.38163	99	4.0	0												0	0
Lemon	8/23/04	39.25486	-86.38220	100	3.0	0												0	0
Lemon	8/23/04	39.25548	-86.38263	101	4.0	0												0	0
Lemon	8/23/04	39.25623	-86.38263	102	4.0	1	1											1	0
Lemon	8/23/04	39.25682	-86.38290	103	4.0	1	1	1										2	0
Lemon	8/23/04	39.25742	-86.38358	104	4.0	0												0	0
Lemon	8/23/04	39.25794	-86.38380	105	5.0	0												0	0
Lemon	8/23/04	39.25856	-86.38344	106	4.0	0												0	0
Lemon	8/23/04	39.25895	-86.38246	107	3.0	1					1							1	1
Lemon	8/23/04	39.25943	-86.38187	108	4.0	3					3							1	1
Lemon	8/23/04	39.25929	-86.38254	109	3.0	5				1	5							2	2
Lemon	8/23/04	39.25921	-86.38331	110	3.0	2	2											1	0
Lemon	8/23/04	39.25954	-86.38430	111	4.0	0												0	0
Lemon	8/23/04	39.26006	-86.38485	112	6.0	0												0	0
Lemon	8/23/04	39.26133	-86.38354	113	4.0	1			1									1	1
Lemon	8/23/04	39.26113	-86.38429	114	5.0	0												0	0
Lemon	8/23/04	39.26050	-86.38575	115	5.0	1	1											1	0
Lemon	8/23/04	39.26066	-86.38646	116	5.0	1	1											1	0
Lemon	8/23/04	39.26156	-86.38736	117	4.0	1	1	1										2	0
Lemon	8/23/04	39.26179	-86.38863	118	2.0	0												0	0
Lemon	8/23/04	39.26232	-86.38947	119	3.0	1	1											1	0
Lemon	8/23/04	39.26287	-86.38987	120	3.0	1			1									1	1
Lemon	8/23/04	39.26320	-86.39026	121	3.0	0												0	0
Lemon	8/23/04	39.26315	-86.39083	122	3.0	3					3							1	1
Lemon	8/23/04	39.26285	-86.39168	123	3.0	3					1	3						2	2
Lemon	8/23/04	39.26307	-86.39237	124	2.0	3	1				2	1						3	2
Lemon	8/23/04	39.26306	-86.39318	125	4.0	4	4											1	0
Lemon	8/23/04	39.26268	-86.39464	126	2.0	1						1						1	1
Lemon	8/23/04	39.26275	-86.39576	127	3.0	1	1				1							2	1
Lemon	8/23/04	39.26280	-86.39693	128	3.0	0												0	0
Lemon	8/23/04	39.26308	-86.39807	129	3.0	5	5											1	0
Lemon	8/23/04	39.26284	-86.39897	130	6.0	1	1											1	0
Lemon	8/23/04	39.26283	-86.39983	131	4.0	0												0	0
Lemon	8/23/04	39.26345	-86.40053	132	5.0	0												0	0
Lemon	8/23/04	39.26373	-86.40131	133	2.0	0												0	0
Lemon	8/23/04	39.26422	-86.40234	134	4.0	0												0	0
Lemon	8/23/04	39.26487	-86.40294	135	3.0	1	1											1	0
Lemon	8/23/04	39.26524	-86.40327	136	3.0	0												0	0

Species Codes	
BIBE	Bur marigold
CEDE4	Coontail
CH?AR	Chara
ELCA7	Elodea
LEMN	Duckweeds
MYHE	Broadleaf watermilfoil
MYSI	Northern watermilfoil
MYSP2	Eurasian watermilfoil
MYVE	Whorled watermilfoil
NAFL	Slender naiad
NAGU	Southern waternymph
NAMA	Spiny naiad
NAMI	Brittle waternymph
NELU	American lotus
NI?TE	Nitella
NOAQVG	No aquatic vegetation
NULU	Yellow pond lily
NYTU	White water lily
POAM	Large-leaf pondweed
POCR3	Curly-leaf pondweed
POFO3	Leafy pondweed
POGR8	Variable pondweed
POIL	Illinois pondweed
PONO2	American pondweed
POPE6	Sago pondweed
POPR5	White-stemmed pondweed
POPU7	Small pondweed
PORI2	Richardson's pondweed
POZO	Flat-stemmed pondweed
UTMA	Common bladderwort
VAAM3	Wild celery, eel grass
WO?LF	Watermeal
ZAPA	Horned pondweed
ZODU	Water stargrass

Lake	Date	Latitude	Longitude	Site	Depth	RAKE	MYSP2	POCR3	CEDE4	CH?AR	NAMI	POPU7	ELCA7	PONO2	ZAPA	NELU	ALGA	SpeNum	NatSpeNum
Lemon	8/23/04	39.26611	-86.40345	137	2.0	4	4											1	0
Lemon	8/23/04	39.26683	-86.40440	138	4.0	5	5											1	0
Lemon	8/23/04	39.26713	-86.40608	139	6.0	2	2											1	0
Lemon	8/23/04	39.26710	-86.40715	140	5.0	0												0	0
Lemon	8/23/04	39.26785	-86.40980	141	5.0	1	1											1	0
Lemon	8/23/04	39.26837	-86.41026	142	3.0	1	1											1	0
Lemon	8/23/04	39.26866	-86.41064	143	3.0	0												0	0
Lemon	8/23/04	39.26906	-86.41092	144	1.0	0												0	0
Lemon	8/23/04	39.26913	-86.41148	145	4.0	1	1											1	0
Lemon	8/23/04	39.26988	-86.41218	146	4.0	1	1	1										2	0
Lemon	8/23/04	39.27007	-86.41352	147	4.0	3	3											1	0
Lemon	8/23/04	39.26985	-86.41466	148	2.0	3	3				1							2	1
Lemon	8/23/04	39.27068	-86.41527	149	4.0	3	2				1	1						3	2
Lemon	8/23/04	39.27165	-86.41580	150	5.0	2	2											1	0
Lemon	8/23/04	39.27247	-86.41630	151	5.0	2					2	1						2	2
Lemon	8/23/04	39.27326	-86.41697	152	5.0	1	1											1	0
Lemon	8/23/04	39.27384	-86.41749	153	4.0	1	1	1										2	0
Lemon	8/23/04	39.27389	-86.41913	154	4.0	1						1						1	1
Lemon	8/23/04	39.27341	-86.41906	155	4.0	0												0	0
Lemon	8/23/04	39.27269	-86.41975	156	4.0	1	1											1	0
Lemon	8/23/04	39.27222	-86.42076	157	5.0	1	1											1	0
Lemon	8/23/04	39.27221	-86.42154	158	2.0	4	4				1							2	1
Lemon	8/23/04	39.27288	-86.42206	159	3.0	2	2		1		1							3	2
Lemon	8/23/04	39.27295	-86.42316	160	6.0	4	4											1	0
Lemon	8/23/04	39.27243	-86.42354	161	5.0	5	5											1	0
Lemon	8/23/04	39.27131	-86.42397	162	4.0	5	5											1	0
Lemon	8/23/04	39.27143	-86.42516	163	5.0	5	5											1	0
Lemon	8/23/04	39.27234	-86.42564	164	5.0	0												0	0
Lemon	8/23/04	39.27193	-86.42752	165	5.0	0												0	0
Lemon	8/23/04	39.27117	-86.42714	166	4.0	5	5											1	0
Lemon	8/23/04	39.26991	-86.42614	167	6.0	0												0	0
Lemon	8/23/04	39.26854	-86.42398	168	5.0	0												0	0
Lemon	8/23/04	39.26780	-86.42208	169	4.0	3	3											1	0
Lemon	8/23/04	39.26726	-86.42129	170	6.0	4	4											1	0
Lemon	8/23/04	39.26611	-86.42219	171	3.0	2	2											1	0
Lemon	8/23/04	39.26554	-86.42208	172	3.0	1	1				1							2	1
Lemon	8/23/04	39.26459	-86.42215	173	4.0	1	1				1							2	1
Lemon	8/23/04	39.26377	-86.42245	174	1.0	1	1				1							2	1
Lemon	8/23/04	39.26373	-86.42168	175	5.0	1	1		1									2	1
Lemon	8/23/04	39.26337	-86.42095	176	3.0	1	1		1									2	1
Lemon	8/23/04	39.26265	-86.41961	177	5.0	0												0	0
Lemon	8/23/04	39.26215	-86.41894	178	4.0	0												0	0
Lemon	8/23/04	39.26141	-86.41885	179	4.0	0												0	0
Lemon	8/23/04	39.26094	-86.41895	180	1.0	1	1								1			2	1
Lemon	8/23/04	39.26142	-86.41836	181	4.0	1	1		1									2	1
Lemon	8/23/04	39.26186	-86.41796	182	4.0	0												0	0
Lemon	8/23/04	39.26510	-86.41725	183	2.0	1					1	1						2	2
Lemon	8/23/04	39.26571	-86.41715	184	2.0	5	1			2	5							3	2
Lemon	8/23/04	39.26612	-86.41733	185	2.0	1					1	1						2	2
Lemon	8/23/04	39.26594	-86.41664	186	3.0	2	1				2							2	1
Lemon	8/23/04	39.26540	-86.41692	187	1.0	4				1	4							2	2
Lemon	8/23/04	39.26497	-86.41706	188	2.0	4				2	2							2	2
Lemon	8/23/04	39.26217	-86.41724	189	5.0	1	1											1	0
Lemon	8/23/04	39.26227	-86.41673	190	5.0	1	1											1	0
Lemon	8/23/04	39.26230	-86.41609	191	2.0	2	2											1	0
Lemon	8/23/04	39.26256	-86.41559	192	2.0	1	1											1	0
Lemon	8/23/04	39.26270	-86.41507	193	3.0	1	1											1	0
Lemon	8/23/04	39.26291	-86.41461	194	2.0	1	1											1	0
Lemon	8/23/04	39.26288	-86.41418	195	3.0	0												0	0
Lemon	8/23/04	39.26257	-86.41405	196	2.0	1	1											1	0
Lemon	8/23/04	39.26254	-86.41375	197	1.0	1	1											1	0
Lemon	8/23/04	39.26290	-86.41395	198	5.0	0												0	0
Lemon	8/23/04	39.26299	-86.41346	199	5.0	0												0	0
Lemon	8/23/04	39.26270	-86.41278	200	3.0	1	1											1	0

Species Codes	
BIBE	Bur marigold
CEDE4	Coontail
CH?AR	Chara
ELCA7	Elodea
LEMN	Duckweeds
MYHE	Broadleaf watermilfoil
MYSI	Northern watermilfoil
MYSP2	Eurasian watermilfoil
MYVE	Whorled watermilfoil
NAFL	Slender naiad
NAGU	Southern waternymph
NAMA	Spiny naiad
NAMI	Brittle waternymph
NELU	American lotus
NI?TE	Nitella
NOAQVG	No aquatic vegetation
NULU	Yellow pond lily
NYTU	White water lily
POAM	Large-leaf pondweed
POCR3	Curly-leaf pondweed
POFO3	Leafy pondweed
POGR8	Variable pondweed
POIL	Illinois pondweed
PONO2	American pondweed
POPE6	Sago pondweed
POPR5	White-stemmed pondweed
POPU7	Small pondweed
PORI2	Richardson's pondweed
POZO	Flat-stemmed pondweed
UTMA	Common bladderwort
VAAM3	Wild celery, eel grass
WO?LF	Watermeal
ZAPA	Horned pondweed
ZODU	Water stargrass